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Engineering News-Record

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February 7, 1924

Turning the Yellow River of China Back Into Its Channel

Building the Highest Hydraulic Fill Earth Dam

Eight-Story Concrete Building Fails During Construction

Municipal Finance and Improvement Policies

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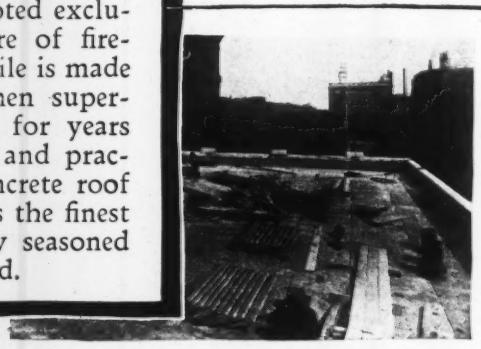

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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Politics and Conservation

WASHINGTON'S reaction to the Teapot Dome scandal is entirely political. An issue has been suddenly thrust into what promised to be a colorless presidential campaign and the politicians have pounced on it like a terrier on a rat. The seasoned reporter at the capital, who watches from a non-partisan isle of safety the performance of the political marionettes, has now before him one of the best acts in years. But to those outside the political bull-ring the disclosures are profoundly depressing, not alone because a small town politician raised to national prominence has been shown entirely lacking in the sense of responsibility of public office, not only because the Navy is suspected of justifying the means by the end to be achieved, not alone because of the callousness displayed by the millionaire Doheny in his smug and self satisfied public tale of prominent officials and ex-officials dancing to the wave of his oily wand, but because of the insidious effect on public confidence in our institutions that all of these sordid details of the scandal must have. The bitter-end conservationists have the best ammunition they have ever had, and the argument that the best way to develop national resources is by private enterprise under government control has had a body blow. The sad thing is that this doubt as to the integrity of public officials and the certainty of the cupidity of the monied producing interests is founded on one incident in which weak men participated and that by it the unselfish public servant and the honest private developer suffer.

Winter Failure of Concrete

FOLLOWING the habit of structural accidents, the Benton Harbor collapse is different from all of the long line of concrete failures that have preceded. In the first place, nothing similar to the slow, seemingly deliberate, disintegration exhibited in this case has been reported previously. In the second place, the collapse came as near to 100 per cent failure as could be, which is equally unprecedented. Both of these features are puzzling, and perhaps both are related in some way to the cause of the failure. Other features of the case are more common—the fact that it is a winter failure, the doubts relating to the quality of the aggregates and of the cement, and the uncertainty as to whether the cold-weather precautions taken were adequate. On the scanty data available at present, freezing or at least delayed set of the concrete is most under suspicion; but, as T. L. Condron points out in his report on another page, the framework of the lower stories had ample time to set up before heavy frost, yet it went down like the rest and shows the same crumbling characteristic. In any event it is not easy to reconcile the long-drawn-out collapse, occupying more than twenty-four hours, with any known weakness of winter concrete. Regardless of the final findings of cause, however, it is particularly regrettable at the present time that through this accident doubt should be cast on the wisdom of winter building, when strong efforts are being made to do away with seasonal work in building operations. It might also be noted that the questions recently raised concerning the sufficiency of present-day knowledge of cement may find encouragement in this most serious of winter failures. Nothing has yet been advanced, so far as we know, to show that cement can be made more insensitive to cold by changing its constitution, though of course it would be futile to deny such a possibility in advance.

Light on "Municipal Extravagance"

ALLEGATIONS of "municipal extravagance" have been common of late. Rarely have these been based on a careful examination of readily available statistics. Where specific figures have been cited almost never has there been an attempt to reduce these to a common basis of comparison in the light of post-war conditions. Still further has it been from the minds of the critics to attempt to set up a standard by which a city could judge whether a proposed increase in operating or capital expenditure would be financially justified or whether the cost of a permanent improvement might best be met from current taxes, from assessment for benefits or from a bond issue. Elsewhere in this issue, Mr. McGhee has rendered valuable service by taking from the Census Bureau's Financial Statistics of Cities certain per capita figures from 1903 to 1921 and applying thereto correction factors to show how the yearly figures compare when reduced to dollars of the same purchasing power. The results will surprise those who have not gone into the matter themselves, for with these corrections the increases shown by the crude figures largely disappear. Mr. McGhee then shows how temporary expedients may be used to stave off some of the burdens of high prices and passes to a study of how a city may determine whether or not a proposed municipal improvement is financially warranted. Here and elsewhere in his article he makes the sound suggestion that the use of assessments for benefits as a means of meeting the cost of municipal improvements might well be used more often than it is. It is by such analyses, comparisons, interpretations and suggestions as these rather than by parrot-like cries of "municipal extravagance" that a real municipal economy will be effected.

Action on Contract Bonding

PROGRESS in a substantial measure was made by the roadbuilders and general contractors, in convention recently in Chicago, toward harmonizing the dispute which has developed over contract bonding practices. Briefly, the action initiated at New Orleans by the state highway officials and the general contractors, which was to call into their joint-committee conferences representatives of the surety bonding companies, was

confirmed by the two conventions in Chicago and supported by officials of leading surety companies. This decision to thresh out their differences over the conference table very materially simplifies the contract bonding situation. It reaches even farther and promises results which, so far, all the long-distance debating has not given. No small part of this promise lies in the changed attitude of mind on both sides which came about as the leaders of the conventions got into lunch-table and lounging-room talks and in these unofficial sessions came to see each other's viewpoint and to know each other as men disposed to be fair and considerate in business. Altogether there is a real prospect of constructive work in contract bonding reform by the enlarged joint committee whose meetings will begin soon.

Spending Money on Existing Parks

THE PROPOSAL to spend several million dollars to roof over the New York Central's tracks along Riverside Drive at New York City is another example of the common tendency to spend money in embellishing existing parks that are already adequate, rather than to spend it on providing new park spaces. Almost every city has one or more examples of it; the Riverside Drive proposal is conspicuous only on account of the amount involved and the fact that some parts of the plan are of timely value. If the seven miles of New York Central tracks along Riverside Drive at New York City are ever to be roofed over to provide a new roadway and more park space then the time to plan for it is now—when the New York Central's scheme for the reconstruction of its whole West Side line is waiting the approval of the Transit and Public Service Commissions. For this reason Controller Craig's idea that a viaduct over the New York Central yards below 72nd Street would greatly improve traffic conditions on Broadway below that point is a good one. But, except for the building of that viaduct, we see no immediate need for the suggested expenditure of vast sums of money on an already beautiful parkway in a high class residential district while great areas in the congested districts are without sufficient park space. All that should be done now is to see that the New York Central's structures above 72nd Street are designed in such a way that the roadway deck can be added at some later date. Below 72nd St. a viaduct seems both reasonable and desirable, but the money is not park money, it is traffic relief money. Park money, not only in New York but everywhere, should be spent in improving or in making new parks where they are most needed, not in adding to parks that are already large enough and sufficiently well equipped for the needs of the surrounding community.

Hydraulic Fill Dam Nomenclature

HYDRAULIC methods of consolidating embankment in earth dams of recent construction have varied greatly from the original sluicing methods which gave engineers the name—hydraulic-fill dams. In the case, for example, of the notable Davis Bridge dam described in this issue the material hauled in without water selection and deposited along the edges of the dam embankment is washed down the beaches and into the core pool by streams from hydraulic giants. Again in several of the large dams for the Miami Conservancy District the material, hauled in by trains and dumped into large bins of timber and concrete, was there broken up and mixed by giants and sluiced into sumps from which it was pumped to the dam embankment and there deposited very perfectly in the traditional manner of hydraulic-fill dam construction.

Quite different methods, of course, are represented at Wichita Falls, Texas, where earth deposited mechanically in layers was consolidated by pounding and on some of the Miami Conservancy District dams where parts of the embankment placed mechanically were sloughed and compacted by water injection by means of nozzles inserted deeply into the fill. These last methods obviously cannot be designated as hydraulic fill methods.

Do not the methods at Davis Bridge dam and in the Miami Valley fall also in some measure short of the original conception of hydraulic fill construction? In some of the dams for the Miami District the natural bank of material was broken down by giants and sluiced to the pump sumps instead of being excavated mechanically and hauled by train to the pumps; water selection of material prevailed from the borrow pit to the dam embankment. This was the manner of things in the first western earth dam operations which gave us the term hydraulic fill as a dam construction process. Is it not the true hydraulic-fill process?

Obviously the answer to this question has no very material significance except as it clarifies thought. The dams in the Miami Valley built by supplying the pump sump with material brought in by cars loaded by dragline excavators are perhaps just as good as, or, it may be, better than, earth dams built by water carriage of material from the borrow pit to the pump sump. But precision of thought is rather needed, for each of the processes of water consolidation mentioned have been written of by engineers as examples of the hydraulic fill method of constructing earth dams.

If the Davis Bridge dam is to be considered a hydraulic-fill dam, and there may be no good reason why it should not be so considered, it is the highest structure of its type ever constructed. Incidentally, another type of dam, the rock fill, likewise native to the Pacific Coast, is setting its record of greatest height in the Dix River dam now under construction near Danville, Ky.

Reforestation and Wood Conservation

DEPLETION of the nation's stock of standing timber has recently crystallized into a definitely recognized national problem. A few states have been active in forest care and reforestation for a number of years, and the state of Washington recently passed a forest-land purchase bill based on a broad plan for maintaining the huge timber values on which the prosperity of the state in large part depends. National action has been limited to the reservation of national forests and the control of timber cutting in them, leaving the general problem of re-creating the present commercial forests untouched. It seems to be a fact that timber-land owners and lumber companies can afford to cut timber but cannot afford to reforest and hold the land for another crop. Such operations can be carried out with success only on a scale far beyond the capability of any individual interest. Therefore, the lumber and timber interests have come to join hands with the forest conservation advocates in drafting a reforestation law.

The most radical and perhaps on all accounts most

noteworthy proposal is that contained in a bill drawn up by a committee directed by Gifford Pinchot, Governor of Pennsylvania, which undertakes to establish government supervision of all timber utilization operations, and to encourage conservation methods of timber cutting and other forest exploitation by taxing all operations and returning the bulk of the tax in the form of a bonus to those operations which are carried out in conformity with government regulations. Purchase of reforestation land is also provided for. A rather different bill has been drafted by a Senate committee and introduced by Senator McNary. This bill provides for equal contributions of state and nation to forest supervision and reforestation, but apparently does not contemplate purchase of reforestation land except such as is located "within the watersheds of navigable streams," and "will promote or protect the navigation of streams or will promote the production of timber thereon."

That promotion of constructive forestry is a national need can hardly be open to doubt, in view of the changing grades and qualities of lumber and the increasing prices. What form this promotion should take seems to be still subject to wide differences of opinion. Early discussion of the subject will be likely to hasten the adoption of a workable policy, which is desirable for the reason that even immediate beginning of work in reforestation would hardly be able to reach a balance with timberland depletion in less than several decades.

Springing from causes related to those back of the reforestation movement, the efforts in behalf of more efficient lumber utilization have produced at least one result. Basic lumber and timber sizes have been brought near to the point of standardization by more definite agreement on minimum sizes of dressed lumber. This is in itself a trifling advance, as may be seen particularly from the fact that lengthy conferences and much circularization and correspondence were devoted to the question whether the minimum dressed 1-in. thickness should be $\frac{25}{32}$ or $\frac{24}{32}$ in. However, the aggregate of the efforts being made to reduce weight through unnecessary or ineffective grading, through variation of sizes, and similar losses is of decisive importance to wood conservation.

The Truth Prevails

THE expected has happened in the case of the engineers indicted for conspiracy to control the construction program of the late war. At the first opportunity for judicial review the charges have been thrown out of court. Judge Hoehling's decision, abstracted in our news pages, is comprehensive and complete; it strips the malicious and all embracing indictment of its implications of widespread criminality and reduces the charges to three—that the men accused conspired to deprive the Corps of Engineers of their statutory prerogatives, to violate a statute requiring competitive bidding on war construction, and to influence higher officials to commit these illegal acts, the main result of which was to put in effect the cost-plus contracts to the loss of the government and to the benefit of the contractors. The judge demolished all these charges, but he goes further and condemns the general atmosphere of criminality and graft that surrounds the indictment but which is justified neither by the facts or by the specific charges. The decision is a complete vindication of the men so unjustly drawn into the meshes of a political persecution.

The men thus accused did not need this vindication in the eyes of their professional brethren. Two distinguished committees of engineers had already guaranteed their innocence of wrongdoing after a thorough investigation of the acts the Attorney General called crimes, and engineers have greater faith in the judgment of Arthur Talbot, Charles T. Main, E. W. Rice, F. L. Cranford, Francis Blossom and Charles A. Morse than they have in that of Harry M. Daugherty. But the general public knew only that the men who planned the war construction program had been indicted for conspiracy to defraud the government, and the stigma of indictment hung over them for fourteen months. That stigma has now been removed, but its removal cost its victims a great deal of money and mental stress. For this unjust burden on men who served their country fairly and honestly in its hour of need the Attorney General of the United States and his subordinates must take all the blame.

Criminal procedure requires that before a man can be tried for violation of the law he must be formally charged with that violation by a Grand Jury to which a fair presumption of guilt is presented by a government attorney. The accused has no representation before that jury; the entire case is in the hands of the prosecuting attorney. By its very nature the fairness of this procedure must rest on the fairness of that attorney, and our criminal jurisprudence rests on the assumption that the prosecuting attorney has as high a sense of justice as the judge who eventually tries the case. When that attorney is one of a group hired for the specific purpose of justifying the charges made by a partisan majority of a congressional committee just prior to a presidential election, and dependent for his continuation in office on the continued bringing of indictments, the fairness of the attorney is justly subject to suspicion. That suspicion is turned into conviction in the case of the construction division indictment. Judge Hoehling's analytical destruction of that indictment only confirms the self-evident falsity of the charges made against Benedict Crowell, William A. Starrett, Morton C. Tuttle, Clair Foster, Clemens Lundoff, John H. McGibbons and James A. Mears. The Department of Justice has now one more blot on its already soiled escutcheon.

Every engineer has an individual duty in spreading the result of this case. Unfortunately, the news of misdoing travels faster and farther than news of vindication. The whole engineering profession was besmirched by the charges against the men who devised our war construction program, not only because those men were respected members of the profession, but because what they did had been approved by committees of our technical societies. The charges have now been disproved, under the closest of judicial scrutiny, but their sinister effect will still go on. No stone should be left unturned by the engineers of this country in putting before the people the gist of Judge Hoehling's decision.

The public should know that an unprejudiced judge has ruled that the charges so freely made against the engineering control of our war construction were for the most part reckless and unsustained and that the specific accusations of misconduct were untrue. Here is a real opportunity for public service that all technical societies and local branches should be quick to embrace.

Turning the Yellow River Back Into Its Channel

Chinese River Cuts 6,000-ft. Gap Through Main Dike—New Channel Excavated and Old Channel Closed by Rock-Fill Dam—Cost of Excavation by Chinese Labor

Manuscripts describing this work were received simultaneously from Mr. Whitham and Mr. Todd. Rather than wait the long time necessary to get mail back and forth to China the accompanying article was prepared from the available material. Acknowledgments are made to both the original sources.—EDITOR.

AN INTERESTING piece of river work was completed last summer on the lower Yellow River, in China, on which American engineers were employed to repair a serious break in one of the dikes and to turn back the river into its former course. The break occurred at Kung Chai Kou, 8 miles above Li Chin, in Shantung Province, in late July, 1921, at the height of the flood season. Though the break was discovered when it was only 50 ft. wide, funds for making repairs were too slow in coming and the next month saw the break widen to 6,000 ft. and the old bed below the break left dry, except for a narrow channel about 40 ft. wide where backflow from the ponded area outside the break worked back into the lowered stream bed of the river.

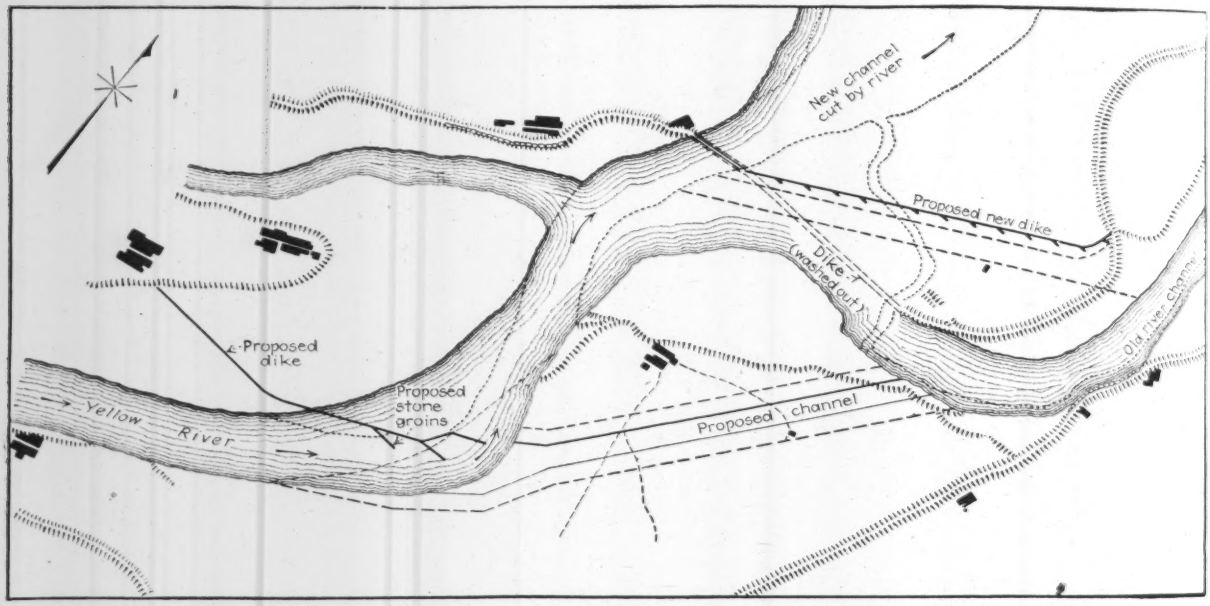


FIG. 1—METHOD OF CLOSING BREAK IN YELLOW RIVER DIKE PROPOSED BY CHINESE ENGINEERS

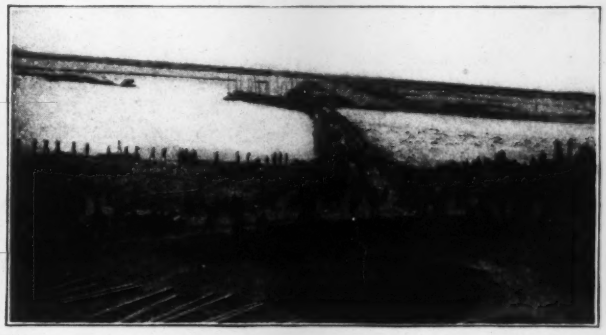
The lower portion of the Yellow River Valley is made up of a vast delta, which is peculiar in that it extends nearly 400 miles inland from the Shantung Mountains on the coast. It is probable that at one time this lower portion of the valley was a shallow inland sea which has since been filled up by silt brought down by the Yellow River. For the past three or four thousand years of recorded history the Yellow River has frequently, almost annually, changed some part or all of its course across this densely populated delta. During all these centuries the Chinese people have endeavored, by the use of dikes, to keep the river within its course, so that the break in the dike which occurred in July, 1921, was nothing unusual. The Shantung Yellow River Bureau made surveys of the surrounding country the following fall and proposed the scheme for closing the gap in the dike and turning the river back into its former channel, shown in Fig. 1. This plan of operation included a cutoff channel across the point that had been built up by silting within the main dike and the construction of a new dike across the flood flat on the left bank of the river. This dike was to be connected with three stone groins projecting far enough out into the river to throw most of the flood flow into the newly excavated channel. No provision was made for a dam to cut off the flow through the dike as it was hoped that after the flood had washed the new cutoff channel deep enough, the main stream would go that way and the breach in the north dike could be repaired by the usual Chinese method of gradually building out from the two ends of the broken dike with great bundles of kaoliang stalks and heavy mats, at times of low water, until the breach was small enough to close it by floating in a great bundle of stalks and then packing the dike with mats and earth until it once more became watertight.

Money to finance the work was raised by the Shantung government and the China International Famine Relief Commission, the latter commission contributing 25 per cent of the cost. When estimates on the proposed work were received, it was found that a Chinese-American firm in Shanghai, the Asia Development Co., estimated that it could be done for $1,500,000 in Chinese currency, or about $750,000 U. S. currency, which figure was less than half of the estimated cost according to the Chinese method of doing the work; conse-

Moving earth with basket men

Camp entrance through emergency dike

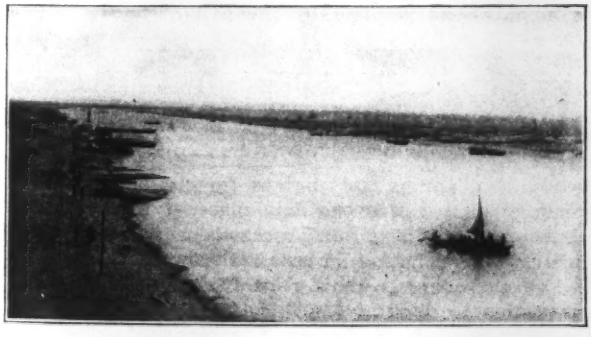
Native quarters dug-in for warmth



Dumping rock in the diversion dam

Pile driver timber hauled 40 miles

Turning water into new channel



River flowing in the new channel

Ice jam that threatened the work

FIG. 2—DETAILS OF THE WORK AND OF CHINESE METHODS OF CONSTRUCTION

quently the contract was awarded to the Asia Development Co. and work was started on Dec. 1, 1922. The plan as proposed by the engineers of this firm was similar to that proposed by the Chinese engineers, except that it included a rock-fill dam across the river, just at the end of the new dike D, Fig. 3, and omitted the three stone groins, substituting one of kaoliang stalks built a little farther upstream. The main cutoff

channel remained about the same as in the Chinese plan, but below this channel, through the old river bed, a smaller channel was excavated for a distance of 7 miles downstream, each channel having a gradient of 1 in 10,000. The cutoff, or leading channel, was made 500 ft. wide at the top and 300 ft. wide on the bottom, with an average depth of 12 ft., and the scouring channel farther downstream was made 100 ft. wide on the bottom and served to supplement and straighten the old channel of the river. These channels were designed to take the low water flow, ranging from 15,000 to 40,000 sec.-ft., and to act as guiding channels for the flood flow, which exceeds 300,000 sec.-ft., in cutting a wider and deeper channel. The soil is all very fine silt or loess, easily scoured out by currents of from 5 to 8 ft. per second velocity. Two-thirds of the earth taken from the leading channel was thrown up to build dike A, Fig. 3, which is 200 ft. wide and 14 ft. high.

The dam is the most interesting feature of this piece of work. It was built after the leading and scouring channels had been excavated, and consists of a rock-fill dam built around a substantial timber trestle 800 ft. long and 30 ft. wide, with four pile bents spaced 10 ft. on centers. The waterproofing of the face of this dam was accomplished by the use of 10,000 native reed mats and 300,000 burlap sacks filled with loess. The silting in front of the structure helped to make it watertight. Neither clay nor gravel were available for this work and the rock was quarried 100 miles up river and taken downstream in small river junks. It was all one-man sized rock and was placed by hand from small cars pushed by hand, loaded from the rock yards along the bank where the junks had discharged. A woven-wire mesh mattress was laid on the bottom of the river before the rock fill was started. After the dam was completed the old dike was repaired by the construction of new dike E, Fig. 3, and was straightened out by the construction of dike C behind the old dike, where it was liable to be scoured by the river in its new channel.

As this piece of construction work was 77 miles from the nearest railroad and as roads were poor or entirely lacking, one problem which had to be met was that of providing adequate highways. This work included the construction of 40 miles of new road under the jurisdiction of the Shantung International Relief Commission and the resurfacing of 37 miles of old road.

Work was begun early in December and carried on throughout the winter, despite the ice jam which nearly wiped out the camp at the time of the spring break-up, and the work was practically finished by July, 1923, just ahead of the summer floods. During the winter from 3,000 to 4,000 coolies were employed on channel excavation and rock quarrying, and in summer the number of coolies was increased until at one time it reached a total of 23,500. Work on the trestle was not started until March on account of the danger of ice jams in January and February. No great difficulty was experienced in this part of the work as the water was never over 22 ft. deep and the pile penetration about 25 ft.

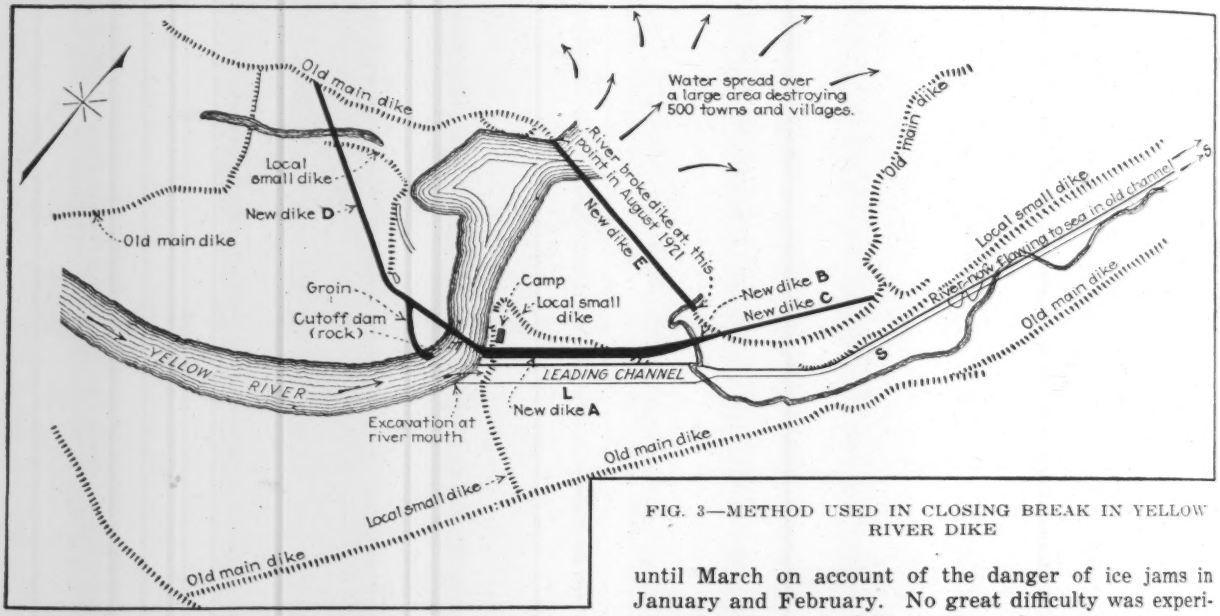


FIG. 3—METHOD USED IN CLOSING BREAK IN YELLOW RIVER DIKE

In comparing this work with similar work in America, such as the closing of the Colorado River break at the Hind and Clarke dams in 1906-7, it is to be noted that the cost of labor and of equipment in China makes it advisable to use little special equipment, and do as much as possible by cheap hand labor. Aside from a few pumps and engines for running them, the steam piledriver was the only piece of foreign equipment used. Chinese hand methods were used in dirt moving where basket or wheelbarrow work costs 7c. (U. S. currency) a cubic yard for 450-ft. carry from excavation to dump. The dikes adjoining the ends of the dam were built for 5c. a cubic yard, where the average carry was 150 ft. The men worked in small gangs under a leader, somewhat like a subcontractor in this country. In order to speed up the work, a bonus system was put into effect whereby cash prizes, first, second, and third, were offered to the gang which moved the most dirt in a week. The winning gangs were given flags to fly until lost to another gang.

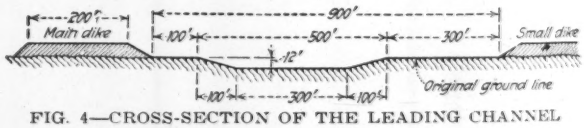


FIG. 4—CROSS-SECTION OF THE LEADING CHANNEL

Long distance hauling by boat was the most expensive feature of the work and the charges ranged from $2 to $5 a ton for the 100-mile haul. Quarrying the limestone rock for the fill cost 12c. a yard.

A construction camp with cantonment buildings for housing the staff and Chinese huts for housing the groups of thirty men was constructed near the site of the dam. The huts cost about $30 apiece. The International Committee of Y. M. C. A. placed trained workers in the camps who provided recreation and aided in the medical and hospital service provided by the company. Only three deaths occurred during seven months, with 10,000 laborers in camp.

The scheme as originally laid out by the Chinese Shantung Yellow River Bureau was prepared under the direction of a Chinese engineer, S. W. Lao. The work as finally laid out and executed was done by the Asia Development Co., Ltd., of which Paul P. Whitham is president and general manager. Oliver J. Todd was chief engineer and L. F. Patstone was assistant chief engineer for the first four months of the work, and for the last four months of the work Mr. Patstone was chief engineer and Irving B. Bush was assistant chief engineer. R. D. Goodrich, of Tientsin, China, acted as a consulting engineer during the early stages of the work. These men were assisted by a staff of Chinese and foreign engineers and supervisors.

Army Engineers Build Disappearing Searchlight Towers

Supported on Trunnion Shafts—Carefully Balanced for Quick Operation—Towers 45 Ft. to 100 Ft. High

By E. D. Cummings
U. S. Assistant Engineer, Washington, D. C.

FOR MOUNTING the 60-in. searchlight of seacoast type the Corps of Engineers, U. S. Army, has built several depressing towers with certain novel features. These structures are called "disappearing searchlight towers" because they are supported on a trunnion shaft and, while carrying the searchlight, can be turned quickly to a prone position and as readily elevated to the vertical. The lowered position makes it possible to provide concealment from horizontal observation by taking advantage of natural objects such as hills, mounds, trees and brush. The ground also offers safe storage for the searchlight, when not in use, and is most convenient for making repairs or alterations to the light or its electrical equipment.

The towers range in height from 45 to 100 ft. but the details are similar. Each frame is made of steel angles and has two short branches or arms at its top. A swinging platform, on which the searchlight is centrally placed and to which the fixed portion of its base is bolted, is suspended between these arms on two pins. It is large enough to permit several men to move around freely and manipulate the light in any direction, vertical or horizontal.

This type of searchlight with its electrical equipment weighs about 8,000 lb. and its top is a little more than 10 ft. above the platform floor. Its light intensity is about one billion candlepower. Electrical considerations make it desirable to have the rheostat near the point of control of light and so the resistance sections are distributed, and attached under the platform floor.

The ends of the trunnion shaft, on which the tower is carried and rotated, are supported at a short distance above the ground on two A-frames between which the weighted short or butt end of the tower swings. Each A-frame has a third leg which acts as a brace, all legs being securely anchored to the masonry foundation. The counterweight itself is mainly of concrete and is cast into the steel frame as a rigid part of the butt end of the tower. To allow for variations in platform loadings provision for exact adjustment of balance is made by means of small blocks of concrete or cast iron. Structurally, the tower is nearly symmetrical about its longitudinal axis; statically, it can be made exactly symmetrical by placing adjusting weights as needed, that is, the center of gravity of the short end of the tower can be brought into a straight line passing through the center of gravity of the long end and the rotation axis of the tower. This is necessary for making resistance to rotation uniform throughout the entire arc of rotation.

The trunnion shaft is keyed to the tower and its journals turn in bronze bushed bearings on the

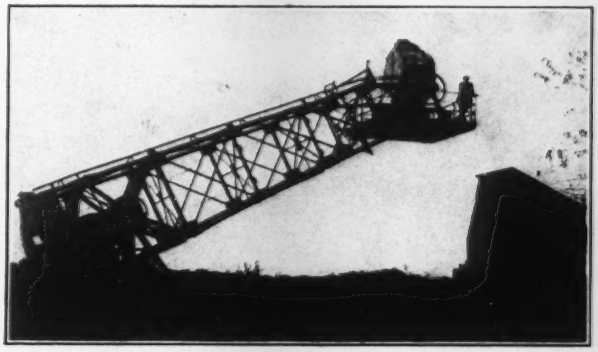


FIG. 1—SMALL TOWER AND SEARCHLIGHT SHELTER

A-frames. The bronze is a special hard alloy and the bearings are self-aligning, so that no binding or pinching can take place, due to more or less imperfect alignment in field erection, slight inequality of compression in the two A-frames, or settlement in foundations. Unit pressure of journals on their bearings in these moveable towers is usually around 1,000 lb. per square inch of projected diametral section, and it is very important to have uniform longitudinal distribution. For lubrication there are no oil grooves in the bottom half of bearing, but there are two grooves in the journal, parallel to its axis, and separated somewhat less than a quadrant. Compression grease cups in the ends of the shaft communicate with these grooves which sweep the entire loaded surface of the bearing in rotation up or down. This method of lubrication is often used in trunnions having heavy pressure. The platform also is suspended so as to allow a certain amount of inaccuracy in alignment of its trunnions or pins without any pinching or binding.

These self-aligning non-binding features of the bearings contribute much to the ease of manipulation of these towers and make hand power operation effective. The small number of friction points, centers of rotation, bearings, etc., and correct balancing are also very important in securing this most desirable result.

Method of Operation—Any of the towers can be operated by one man. The smaller towers can easily be

raised or lowered by one man in less than one minute, and the 100-ft. towers by two men in less than two minutes. With such rates of raising and lowering by hand it is not desirable to introduce the expense and complications of motor operation. There is nothing to get out of order in hand operation, and any considerable increase in speed would introduce danger of shocks in stopping and starting. Shock absorbing cushions are provided at both limits of motion to avoid possible injury to the searchlight projector. The gears are steel and have machined teeth in order to minimize friction. The operating mechanism is double; that is, there are two segmental racks and two rack pinions, two gear wheels, two crank pinions and two cranks, one set on either side. One set would be sufficient to operate the tower because the monolithic concrete counterweight prevents any elastic distortion between the sides of the tower, but two sets provide for the possibility of one being useless from such an injury as might be caused by hostile shot. If both sets of gears were disabled the tower would not fall so long as it was in fair balance and, in case of emergency, it could be raised and lowered by tackle and lines.

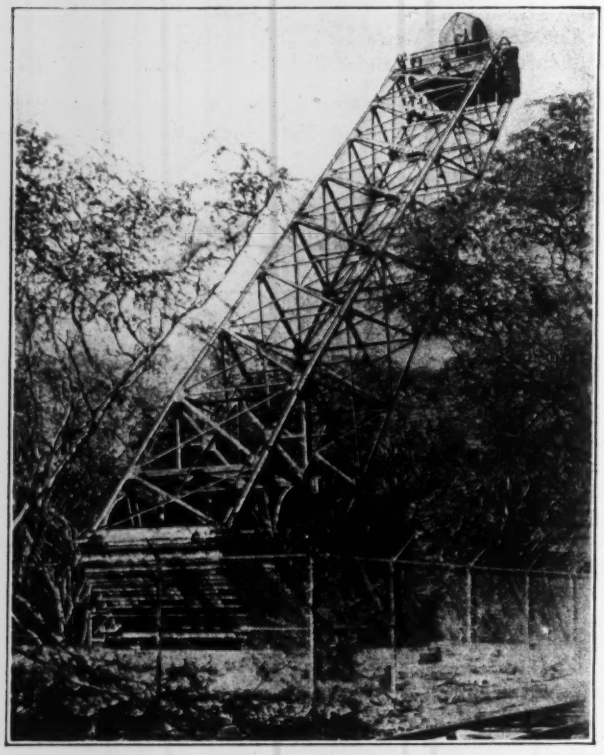


FIG. 2—ONE OF THE LARGE TOWERS PARTLY ELEVATED
Showing method of adding to counterweight

The resultant center of gravity of the platform and its load of searchlight and electrical equipment is well below their axis of suspension and the unrestrained platform would not overturn, even with several men at one edge, but, in order to prevent oscillations and to maintain the platform horizontal under all conditions of tower rotation and platform loading, a device is used which is called an equalizer. It consists of two chain sheaves, one on the A-frame with its axis coincident with that of the tower trunnions and one rigidly attached to the platform in a similar relation to its axis of rotation, so connected by chains and rods that when the tower is rotated the chain wraps and unwraps equally on both wheels and the platform always remains parallel to the position it had when the sprocket chain was applied. The rods between the chains on the upper and lower sheaves are about ¾ in. in diameter and are preferred to wire rope on account of the stretching of such rope. Turnbuckles provide for adjustments.

With the platform horizontal the equalizer is adjusted to an easy working tension and this is made secure by lock nuts at the turnbuckles. The platform keeps horizontal for any loading and any angular elevation of the tower.

Locking Devices—The tower can be very securely held by brakes at any angle and the searchlight can be operated at any height from the ground up to that given by the vertical tower. The brakes can be padlocked in any position. When at the vertical the tower can quickly be made a fixed structure with a rigid platform independent of the holding power of brakes and equalizer. The tower is locked to the A-frames, anchored to the foundation, and the platform to the tower simultaneously by one movement of a lever at the ground. This is accomplished as follows: Two parallel beams are framed between the corresponding shoes of the A-frames tying the two frames together slightly above the concrete foundation. One beam is just far enough from the trunnion axis so that the swinging butt end of the tower clears it. The other beam is closer to the trunnion axis so that the butt end of the tower swings against it when the tower becomes vertical. The tower is then blocked between the two beams by toggles on a shaft carried by the tower counterweight box and turned by a hand lever. Parallel to this toggle shaft and at the top of the tower supported by brackets thereto, is another shaft carrying toggles for blocking two corners of the platform. The two toggle shafts are connected with each other by a mechanism similar in principle to that of the equalizer, so that the movements of the two shafts are simultaneous. When the tower is rotated to the vertical the angular relation of platform to tower becomes 90 deg. and the two outer corners of platform seat on brackets connected to the tower while the other side of platform swings over its toggle shaft, then the operator turns the base toggle shaft which blocks the butt of the tower horizontally and at the same time the upper toggle shaft turns and blocks the platform vertically.

The toggle lever at the ground can be locked in closed position to prevent tampering by unauthorized persons, also the platform toggle shaft has a hand lock rod controlled by the searchlight operators on the platform who can lock that shaft—and consequently, the whole tower—against any movement which they do not want.

In comparison with fixed towers of the ordinary type, these depressing towers, when elevated, are quite rigid and stiff against wind. Their moments of inertia are relatively large and their centers of gravity relatively near the ground.

When the tower is turned to its prone position, the platform lands on a suitable foundation to which it is automatically secured by a latch that can be locked if desired.

Searchlight Housing—A small steel house is provided to inclose the searchlight when not in use. The house is on grooved wheels for which suitable track is laid on the tower platform and on a foundation adjacent

FIG. 3—TOWER LOCKED IN UPRIGHT POSITION

to the platform landing. The platform hand railing can be opened by means of double gates and the side of the house by means of a rolling steel curtain door. When the platform is landed the house can readily be pushed from its ground position onto the platform and over the searchlight. The curtain door is then closed and fastened inside, and the operator locks the small rear door from the outside. The house can readily be moved by one man. Anchorage resistance against violent storms and winds is provided.

The general scheme of this type of searchlight tower was also used for a railway mount on a large flat-car. A number of modifications were necessary. Only one, however, is mentioned. The counterweight was divided and is carried on two hinged frames, which, when the tower is elevated, straddle the car (in order to obtain greater lever arm), but when the car is to be transported, the tower being down, these frames are swung within the side lines of the car. The counterweight is cast iron. One man can operate this tower. This unit includes a box car which carries the gasoline electric power plant and bunks for men.

Both the general plans and the details necessary to accomplish the desired results were designed by the writer in the regular course of his work for the government and certain patents have been obtained for governmental use. The writer at that time was under the direction of Colonel E. Eveleth Winslow, Corps of Engineers, who initiated the development of these structures. The first tower was erected in a district in charge of Colonel F. V. Abbot, Corps of Engineers.

Extensive Use of Steel Water Tanks at Wheeling, W. Va.

FIVE 1,000,000-gal. steel tanks with provisions for five more form a part of the water-works improvements under way at Wheeling, W. Va. The hilly topography at Wheeling made it impracticable to construct reservoirs in excavation or embankment. A place was found in one of the ravines where space could be leveled off that would accommodate ten or more water tanks of 1 m.g. capacity each. At present only five of these will be built and the contract for them has been let at a total cost of $136,870 (see table for details) for the tanks and the concrete-ring foundation (similar to standard gas-tank construction) on which the sides of the tanks rest. Each tank is 75½ ft. in diameter and 30 ft. high, and is covered. The concrete ring is 3½ ft. wide, 3 ft. deep in earth and disintegrated shale and 1 ft. deep where the ring rests on rock. The ring projects 15 in. beyond the outside of the tank and is provided with a semicircular gutter 8 in. wide and 4 in. deep. A 1½-in. layer of sand is spread beneath the entire bottom of the tank. The bottom of the tank, except where on the ring, rests on undisturbed earth.

SUBSTRUCTURES FOR STEEL RESERVOIR TANKS		
Sewers	$6,100	
Excavation and grading (28,000 cu.yd.)	24,730	
Foundations	12,160	
		$42,990
STEEL RESERVOIR TANKS		
Steel tanks erected	$90,800	
Altitude valve	1,580	
Recording telemeter completely installed with wiring (16,000 ft. of transmission)	1,500	$93,880
Grand total		$136,870

The telemeter is being installed with the transmitter located at the reservoir tanks, and the recorder is being installed in the new pumping station 16,000 ft. away. Poles and crossarms for the wiring are being provided by the city, but the wire and all other material must be furnished and installed by the contractor.

When it was decided to use steel instead of reinforced concrete for these tanks, the *Engineering News-Record* Cost Index, says J. F. Laboon, of the J. N. Chester Engineers, Pittsburgh, who are doing the engineering work on the tanks, new filters and pumps for Wheeling, was 1.15 for tank steel and 1.65 for concrete. It was estimated that a concrete reservoir would cost $160,000, but this was partly due to the topography and to the fact that the site was not readily accessible to hauling of materials. The life of the steel tanks is figured as at least 25 years with ordinary care.

The reservoir tanks are connected to the force mains from the pumping station by means of a 31-in. steel pipe line in which is installed at the reservoir site a 24-in. altitude valve, double acting, so that the water may flow to or from the tanks. This valve will serve to shut off the water from the force mains when the tanks are full.

One of the advantages of having storage provided in units, as has been done, is that when cleaning becomes necessary only a small percentage of the total storage capacity will be made unavailable.

Deepening New York Barge Canal Proposed

Recommendation has been made by Dwight LaDu, state engineer and surveyor of New York, in his annual report to the Legislature that the State Barge Canal be immediately deepened from Waterford to Utica to a 12-ft. depth.

Municipal Finance and Improvement Policies

A Study of Expenditures and Receipts of Cities of 30,000 and Upwards, 1903 to 1921, with Suggestions as to a Policy to Govern Capital Outlays for Improvements

By H. G. McGee
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CONFLICTING protests against high taxes and demands for public improvements have been widespread since 1920. These notes indicate that there is a sound foundation for this conflict and suggest some policies which may tend to reconcile both.

Most of the data have been taken from the "Financial Statistics of Cities," published by the Bureau of Census, and from the Bureau of Labor's estimate of price changes based on 404 commodities weighted according to the 1919 production. Objections to such data are: The latest city reports are for the fiscal year 1921; there are undoubtedly inaccuracies in these reports and they may not conform to the usage of many cities. However, they are practically the only comprehensive summaries of city finance available; and efforts have been made by the census bureau to analyze city accounts and even vouchers, except in 1921, to bring the figures of different cities to a comparable basis.

TABLE I—GOVERNMENTAL REVENUE RECEIPTS OF AMERICAN CITIES OF 30,000 AND OVER AS REPORTED BY BUREAU OF CENSUS IN DOLLARS PER CAPITA*

Year	No. of Cities	Index of Prices	General Property Taxes		Other General Revenues		Earnings of Public Service Enterprises		Special Assessments		Total Revenue Receipts	
			Actual	Corrected	Actual	Corrected	Actual	Corrected	Actual	Corrected	Actual	Corrected
1903	146	85	$12.98	$15.10	$4.14	$4.82	$2.42	$2.82	$1.60	$1.86	$21.14	$24.60
1905	146	86	14.01	16.30	4.38	5.10	2.60	3.03	1.80	2.09	22.79	26.52
1907	146	94	14.64	15.57	5.24	5.56	2.77	2.95	2.02	2.15	24.67	26.23
1909	146	97	16.14	16.63	5.16	5.30	2.89	2.98	2.22	2.29	26.42	27.20
1911	193	93	17.38	18.68	5.44	5.87	2.99	3.21	2.40	2.58	28.21	30.34
1912	195	99	17.90	18.08	5.70	5.75	2.91	2.94	2.45	2.48	28.96	29.25
1913	199	100	17.82	17.82	5.44	5.44	2.87	2.87	2.40	2.40	28.69	28.69
1914†		98										
1915	204	101	18.72	18.60	5.79	5.71	3.10	3.07	2.56	2.54	30.17	29.92
1916	213	127	19.74	15.54	5.71	4.50	3.09	2.43	2.29	1.80	30.83	24.27
1917	219	177	20.48	11.58	5.87	3.31	3.19	1.80	2.50	1.41	32.04	18.10
1918	227	194	21.03	10.83	6.21	3.21	3.39	1.75	2.12	1.10	32.75	16.89
1919	227	206	23.13	11.21	6.52	3.16	3.68	1.78	1.99	.96	35.32	17.11
1920†		226										
1921	183	147	28.84	19.60	8.64	5.88	4.59	3.12	2.25	1.53	44.32	30.13

* The columns of corrected figures are based on 1913 index of wholesale prices of 100 † No figures are published for 1914 and 1920.

Municipal Revenues—Measured in dollars per capita, with no correction for yearly changes in the purchasing power of the dollar, municipal revenue collections and all but one of the general classes of municipal revenues have been increasing for the past twenty years (Table I). General property taxation in 1921 was 122 per cent higher than in 1903 and 62 per cent higher than in 1913. Other general revenues averaged 109 per cent higher in 1921, after prohibition had eliminated liquor license receipts, than in 1903, and 59 per cent above 1913. Public service enterprise earnings rose 90 per cent in 18 years and 60 per cent in the eight years since 1913. Special assessments rose 39 per cent from 1903 to 1921 and 60 per cent between 1903 and 1913, but they fell 13 per cent from 1913 to 1921. All revenues increased 110 per cent between 1903 and 1921; and 55 per cent between 1913 and 1921.

When the crude figures thus far considered are reduced to a comparable basis by dividing them by the index of wholesale prices to determine their exchange values in terms of the buying power of 1913 dollars, they assume a quite different aspect, as is shown by the corrected figures in the second rows of parallel columns, Table I. These adjusted figures indicate a well-defined upward drift in real values for each type of municipal charge from 1903 to 1915, followed by a sharp break during the war inflation and recovery for all but special assessments in 1921. Apparently municipal charges failed to adjust themselves during inflation, accustoming taxpayers during that period to relatively small public charges in terms of their equivalent buying power. In such terms 1921 figures seem to be no higher than might reasonably have been expected from past years and price changes. The decline in special assessment receipts seems to be the one outstanding exception. Individual cities, however, may be expected to show greater changes, dependent upon their growth, than the average of the country has. For per capita municipal revenue collections seem to drift upwards as a city passes a population somewhere between 50,000 and 100,000 (Table II). While this table is based on 1919 only, each year for which reports are available indicates the same upward trend in per capita collections as cities grow larger.

From such evidence it may be fair to assume that existing complaints about high taxes are due: (1) To a quick recovery from the approximately low real war period taxes to 1921; and (2) to the growth of individual cities. Short of reinflation, the taxpayer has apparently little likelihood of experiencing soon a repetition of the low real tax charges of 1916 to 1919. If the prediction of several eminent economists, based on the last two great war inflations, of a long downward trend in prices occurs, and if the failure of taxes to rise as rapidly as prices did may be taken as an indication of a future failure to fall with them, it seems possible that present taxes may appear extremely low before the next ten years are over.

TABLE II—PER CAPITA GOVERNMENTAL REVENUE RECEIPTS OF AMERICAN CITIES OF DIFFERENT POPULATION GROUPS FOR FISCAL YEAR OF 1919 IN DOLLARS PER CAPITA

No. Cities	Population Group	General Property Taxes	Other General Revenues	Public Service Enterprises	Special Assessments	Total
95	30,- 50,000	$17.03	$5.15	$3.08	$1.88	$27.14
66	50,-100,000	16.38	4.36	3.82	1.67	26.23
45	100,-300,000	18.79	5.15	3.14	2.10	29.18
11	300,-500,000	23.94	8.76	4.38	2.45	39.53
10	Over 500,000	28.57	7.54	3.83	1.93	41.87
227	All groups	23.13	6.52	3.68	1.99	35.32

Governmental Costs—The expenditures of local governments have followed a course characteristically like that of their receipts (Tables III and IV).

Municipal expenditures have jumped for everything but improvements. They exceed revenues. Reduced to a uniform buying power basis, the 1913 dollar, public service enterprise costs appear relatively high, general expenses about in line with the drift from 1913, interest relatively low, and improvement outlay extremely low.

Per capita costs, like revenues, tend to increase with the size of the city (Table IV), with the possible exception of public service enterprises. This failure of public service enterprises to conform with the general rule may be due either to differences in efficiency or to the fact that certain groups of cities may include more kinds of enterprises than do others.

Assuming that outlay expenditures for 1914 and 1920, for which the "Financial Statistics" were not published, were about midway between the adjacent years, the volume of outlays adjusted by the index of wholesale commodity prices and by the *Engineering News-Record* construction cost index indicates that at the end of 1921 municipal improvements were somewhat over three years behind the general schedule set up by the expenditures from 1903 to 1915 (Table V). Apparently demands for additional public improvements are justified.

TABLE III—GOVERNMENTAL COST PAYMENTS IN U. S. CITIES OF 30,000 AND OVER IN DOLLARS PER CAPITA*

Year	No. of Cities	Index of Prices	General Expenses Actual	General Expenses Corrected	Interest Actual	Interest Corrected	Expenses of Public Service Enterprises Actual	Expenses of Public Service Enterprises Corrected	Outlay Actual	Outlay Corrected	Total Actual	Total Corrected
1903	146	86	$13.25	$15.20	$2.06	$2.40	$1.10	$1.28	$8.23	$9.58	$24.64	$28.46
1905	146	85	13.81	16.08	2.36	2.75	1.07	1.24	8.32	9.68	25.57	29.75
1907	146	94	15.84	16.88	2.56	2.72	1.17	1.24	10.34	11.00	29.91	31.84
1909	146	97	16.06	16.56	2.86	2.95	1.22	1.26	10.18	10.48	30.33	31.25
1911	193	93	16.62	17.87	3.55	3.82	1.26	1.35	11.07	11.90	32.51	34.94
1912	195	99	17.34	17.50	3.68	3.71	1.34	1.35	10.35	10.45	32.72	33.00
1913	199	100	17.31	17.31	3.63	3.63	1.36	1.36	10.29	10.29	32.59	32.59
1914	...	98	...	...	...	...	...	...	...	...	...	...
1915	204	101	18.55	18.35	4.12	4.08	1.41	1.40	10.57	10.45	34.65	34.28
1916	213	127	18.69	14.73	4.12	3.25	1.38	1.09	8.91	7.04	33.11	26.14
1917	219	177	19.07	10.78	4.22	2.38	1.40	.79	8.61	4.87	33.31	18.82
1918	227	194	20.11	10.40	4.34	2.22	1.61	.83	8.11	4.19	34.16	17.64
1919	227	206	21.75	10.56	4.52	2.20	1.92	.93	7.38	3.58	35.58	17.27
1920	...	226	...	...	...	...	...	...	...	...	...	...
1921	183	147	30.24	20.57	5.07	3.50	2.72	1.85	10.99	7.46	49.03	33.38

* The columns of corrected figures are based on 1913 index of wholesale prices.

Problem Is Real Test of Management—In the face of these two facts, that taxes are as high as they ever were, and may go higher, and that improvements are several years behind, it appears that it may take management of a high order to rehabilitate our cities without danger of serious financial difficulties.

Some of the things this type of management may do are: Avoid unprofitable improvement investments chargeable to general taxation; shift improvement burdens from general taxpayers to those who benefit; take advantage of favorable money and construction markets; use temporary expedients; spread improvement recovery over a long period of years.

Municipal Improvement Profits—Municipal improvements usually add real value to adjacent properties. Often they make it possible to extend the residential, commercial, and industrial areas of the city. These increased property values may be reflected in increased tax values in the immediate vicinity of an improvement and are often alleged to increase both actual and taxable values throughout the city. If an improvement financed from general taxation adds enough property values to raise tax valuation enough to carry the improvement charges through increased taxes from that property, it may be considered a profitable improvement investment from the standpoint of the general taxpayer.

Property assessments are based on so many different standards in different cities and the adjustments of valuations are often so slow that per capita assessed valuations, while larger in large cities than in small, do not give very conclusive figures as to the result of municipal improvements. It is planned, however, to compare the expected increase in city income, due to added tax values resulting from improvement, with the cost of the improvement.

Municipal tax rates ordinarily approximate about 2 per cent a year. If complete adjustments of tax values are made as soon as an improvement is financed, it is possible that the community may receive not to exceed 2 per cent of the value added to the benefited property by the improvement each year. This 2 per cent will be available for financing the improvement if the improvement involves no additional operating charges and no increase in the population of the city. Financed by 5 per cent, 20-year bonds, such an improvement will be profitable to the general taxpayers if the value added to the property is more than five times the cost of the improvement.

For instance, suppose a given improvement financed by 20-year, 5 per cent bonds increases taxable property values $1,000,000 as soon as the bonds are sold. During the life of the bond issue, this added taxable value will contribute $20,000 a year. This sum will just about carry interest and principal charges on some $200,000. If more than $200,000 is spent under these most favorable conditions, namely, an immediate increase in taxable property values of five times the cost of the improvement plus no additional operating or maintenance cost to the community, the general taxpayers will have to make an additional contribution in taxes to carry the cost of the improvement.

If improvements involving added population are to be profitable by bringing in more taxes than they take out in costs, the values added to the tax duplicate must be adequate not only to pay interest and principal on the investment plus its cost of operation, plus loss dur-

TABLE IV—GOVERNMENTAL COST PAYMENTS, (IN DOLLARS PER CAPITA), IN U. S. CITIES OVER 30,000, BY POPULATION GROUPS FOR FISCAL YEAR 1919

No. Cities	Population Group	General Expenses	Interest	Expenses of Public Service Enterprises	Outlays	Total
95	30,- 50,000	$16.75	$2.83	$1.82	$4.84	$26.23
66	50,-100,000	15.79	2.60	2.27	6.63	27.29
45	100,-300,000	18.48	3.45	1.67	8.50	32.10
11	300,-500,000	24.67	4.02	2.83	8.65	40.16
10	Over 500,000	25.56	6.19	1.70	7.33	40.78
227	All Groups	21.75	4.52	1.92	7.38	35.58

ing construction and development of the district, but it must also include both the per capita costs of service for the additional population and the general increase in operating costs for the entire city which tend to come with increased population (Table IV).

In the city of Jackson, Mich., in 1916, it was proposed to allot an 80-acre tract then on the tax duplicate for $15,000. Residential development would probably have increased this $15,000 to $500,000. Taxes for the extension of operation probably would have added $3,750 a year or a little over $4.50 per capita for the 800 persons who might live on the tract; taxes for sinking fund would have added $750 a year, sufficient to carry perhaps $12,000 in 5 per cent, 35-year bonds; and the main storm sewer for that district would have cost $75,000. Neglecting interest during construction, as well as maintenance and interest during development, the city faced an almost certain loss of six times

is especially true where state laws must be revised to provide public collection of special assessment bills and backing special assessment bonds with general city credit. The second objection seems to condemn itself: If property is not worth after improvement as much as that improvement cost, an investment of general city taxes during existing financial straits in such an improvement would seem the height of financial folly.

What should be done with such property? Every city needs parks, playgrounds, and breathing spaces. Many of these high, low-lying, or difficult areas to serve might become very real assets instead of liabilities if they were developed as park and playground areas without the addition of extensive and expensive public facilities.

It may be interesting to note that if public improvements were pushed during periods of low prices, as occurred the latter part of 1921 and the first of 1922, and were retarded during the periods of high prices,

TABLE V—STATUS OF MUNICIPAL OUTLAY EXPENDITURES IN 1913—DOLLARS PER CAPITA

Year	Outlay in Dollars	Outlay in 1913 Commodity Dollars	Engineering News-Record Cost Index	Outlay in 1913 Construction Dollars	Assumed Normal in 1913 Commodity Dollars	Assumed Normal in 1913 Construction Dollars	Deficit in 1913 Commodity Dollars	Deficit in 1913 Construction Dollars
1903	8.23	9.58						
1905	8.32	9.68						
1907	10.34	11.00						
1909	10.18	10.48						
1911	11.07	11.90						
1912	10.35	10.45						
1913	10.29	10.29	100	10.29	10.80	10.80	.51	.51
1914	(10.43)	(10.60)	89	(11.70)	10.80	10.80	(.20)	(.90)
1915	10.57	10.45	93	11.40	10.80	10.80	.35	.60
1916	8.91	7.04	147	6.07	10.80	10.80	3.76	4.73
1917	8.61	4.87	181	4.77	10.80	10.80	5.93	6.03
1918	8.11	4.19	187	4.30	10.80	10.80	6.61	6.50
1919	7.38	3.58	199	3.72	10.80	10.80	7.22	7.08
1920	(9.18)	(4.08)	251	(3.66)	10.80	10.80	(6.72)	(7.12)
1921	10.99	7.46	201	5.47	10.80	10.80	3.34	5.33
Accumulated deficit							34.64	36.80
Divided by $10.80 (Average 1907—1913) = Years behind							3.22	3.42

the original assessed value of the property if it had allowed the improvement to proceed.

In Akron, under present tax levies, a $1,000,000 improvement involving additional population must add $12,000,000 to the tax duplicate, before it ceases to increase general taxes and becomes self-supporting.

Based on such evidence it seems that improvement investments by cities from general revenue funds must add almost bonanza property values if they are to show anything but losses to the general taxpayers.

Special Assessments—In the Jackson case referred to above the taxable land values would have increased from $15,000 to $100,000 with the construction of sewers and residential development. While the expenditure of $75,000 by the city at large for sewers was not justified, the addition of $85,000 to the $15,000 assessed valuation by the construction of the $75,000 improvement by special assessment might have been profitable both to the owners of the property and to the city. This same principle will apply in the case of many desirable municipal improvements.

There are two stock objections to special assessment financing: (1) It is often more difficult to finance and collect for special assessment improvements than to charge the whole improvement to the general city pocketbook; (2) often property to be improved does not contain enough value after improvement to justify the assessment charge. The first objection seems to resolve itself simply into the statement that it is more work to do a job right and to maintain a prosperous city pocketbook that it is to do it the easiest way. This

as occurred in 1920 and apparently are occurring in 1923, cities would be tending to lower the peaks of inflation and to alleviate the severity of depressions.

Temporary Expedients—In 1920, when brick paving cost in Akron about $9.40 a square yard the city improved Glendale Ave. with a tar-bound macadam at a cost of $1.78. This improvement was inadequate for the volume of traffic and continued in good condition less than two years. But, during this time, the price of brick pavement declined nearly $3 a square yard, making the temporary investment return the capital and pay a modest profit of 34 per cent a year as well.

Slow Recovery—The improvements which cities failed to make from 1916 to 1919 were diverted to and canceled by the war. The labor, or its equivalent, which would have built them was used for other things—in training camps or in France. So with the materials. They are gone and cannot be recovered. For a price, the production of other things can be slowed up and improvements speeded up. The difference between construction costs and general prices is evidence that there is some pressure now to do this very thing. While this pressure is on, taxpayers pay much in other things for little in improvements; their condition becomes worse.

It may be that if cities proceed on the theory that their pre-war improvement status can be safely reached only when their citizens have saved all that was lost in the war, then a slow improvement program may be developed which will most equitably and successfully meet the conflicting desires for both low taxes and city improvements.

Highway Embankment Construction Across Tidal Marsh

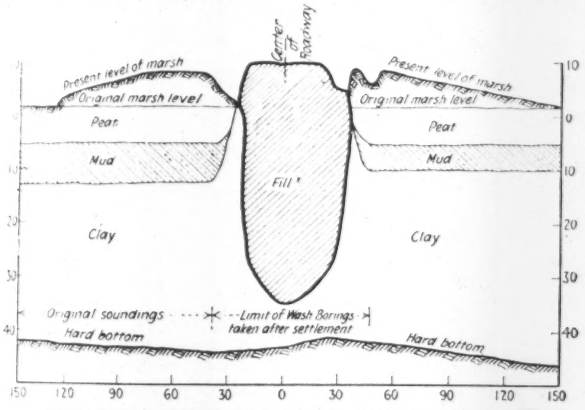
Vertical Settlements of Forty Feet Recorded —Construction Simply a Task of Dumping Enough Material

By W. W. Mack
Assistant Engineer, State Highway Department, Dover, Del.

TIDAL marshes had to be crossed several times in building the Coleman du Pont Boulevard from Wilmington, Del., paralleling Delaware River and Delaware Bay, to the Maryland line, a distance of 98 miles. Soundings taken across these marshes revealed soft material to a depth of from 10 to 60 ft., composed of a mat or crust of roots and vegetable matter 5 to 8 ft. in thickness, closely resembling peat, beneath which was a layer of black mud and a stratum of soft clay underlaid with hard sand and gravel. Investigations showed that earth filling was cheaper than the building of structures. Contracts were let accordingly, and have been completed at the Murderkill and Appoquinimink River crossings.

In most places the crust of the marsh was fibrous and of sufficient strength to support an embankment not exceeding 3 ft. in height, together with the contractors' equipment, without noticeable settlement, but on raising the fill to a height of approximately 7 ft. above the marsh level, which was necessary to prevent the flooding of the roadway by high tides, the crust gave way and the subsidence continued until a vertical settlement up to 40 ft. developed.

Two methods were used by the contractors on the

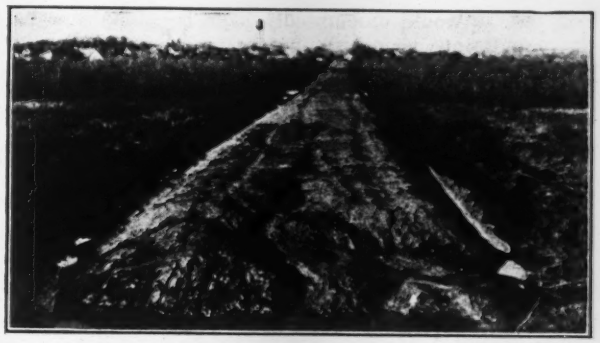


TYPICAL SECTION SHOWING ACTION OF FILL

work: One contractor, using 1-yd. trucks and planking, end-dumped successive layers of the embankment as it settled; the other, by the use of an industrial railway, lifted the track to grade. There was no observable difference in the amount of settlement obtained by the two methods, nor were any special difficulties encountered by the contractors.

The settlement was typical of similar cases observed elsewhere. Longitudinal cracks were first noticed near the middle of the embankment, settlement first taking place in the center, the top of the fill becoming concave in section. As soon as the crust broke through, subsidence was rapid and was accompanied by a corresponding upheaval of the swamp adjacent to the embankment. This upheaval was very irregular but was usually abrupt at the top of the slope, where a vertical fault or slip 6 to 7 ft. in height was sometimes developed. From the high point the surface of the upheaved portion sloped gradually away to the level of the marsh, a distance of 100 to 150 ft.

The settlement continued as new fill was added, until the uplifted material was sufficient to balance the embankment, or until the embankment reached solid bottom. Cross-sections indicate that this upheaval was approximately equal in volume to the amount of filled material. The amount of upheaval seemed in some degree dependent on the rapidity of the filling, rapid additions to the fill not giving the displaced material



COMPLETED EMBANKMENT SHOWING BREAK IN CRUST OF MARSH

time to reach equilibrium by horizontal displacement. This is in some degree substantiated by the fact that the maximum upheaval was observed to come immediately following the completion of the embankment, after which there was a gradual settlement of the raised portion.

In some places, notably in crossing old stream channels, settlement was very rapid and was not accompanied by upheaval, indicating that the swamp material was of such consistency that it acted as a liquid and flowed away or that it was very porous and the weight of the embankment compressed it, driving out the contained water.

As in other cases, observed by the writer, under quite different local conditions, the appearance of clay extruded along the fault at the toe of the slope indicated that the final settlement was nearly reached. Evidently the pressure, being no longer sufficient to cause horizontal or vertical displacement of the whole mass, forced the more plastic clay up through the fissure formed by the vertical fault. This is graphically illustrated in the cross-section given, showing the upheaval of the marsh and the final position of the settled embankment as determined by wash borings.

At one location it required 47,000 cu.yd. of filling to advance the embankment 650 lin.ft., while at another 105,000 cu.yd. were placed in a distance of 2,000 ft., the embankment in each case being approximately 6 ft. above the original marsh level.

In general, little settlement was observed where the swamp was less than 10 ft. in depth or where it was covered with a growth of trees 4 in. or upwards in diameter.

It is probably impossible, owing to varying local conditions, to arrive at any definite rule by which a consistent estimate may be made. However, in the cases being considered it was found that where material was soft enough to allow a ¾-in. gas pipe to be sunk without

difficulty by hand, without the use of a jet, the cross-sectional area of the settled portion below the swamp level was roughly equal to the width of the embankment at grade multiplied by three-quarters of the depth of the soft material.

The force exerted by the moving swamp was considerable and timber test piles driven at the location of bridge abutments were pushed over and disappeared in the shifting mass. Bridge foundations were not started until final settlement of the embankment had taken place, and although considerable pressure was exerted on the cofferdams nothing serious developed and no displacement of the abutments or foundation piles has resulted, as would undoubtedly have been the case had the foundations been built before the embankment was placed.

Plans were prepared and the execution of this work was carried on under the supervision of the Delaware State Highway Department.

Snow Density in Relation to Runoff

IN SNOW surveys undertaken to forecast stream flow it has been generally assumed that the runoff from dense snow comes later than that from light snow, owing to a greater resistance to melting on the part of dense snow. That this assumption may not be correct in all cases is suggested in a recent report by J. E. Church, Jr., of the Nevada Co-operative Snow Survey, whose forecast for the 1923 season was given in *Engineering News-Record*, April 7, 1923, p. 1001. His report, abstracted below, indicates a tendency of super-dense snow to melt prematurely.

The age-long tradition that the runoff from snow of heavy density occurs later than that from light snow seems to have been disproved by the experience of the present season of 1922-23. During March, under practically normal conditions of temperature and depth of snow, the snow cover in the central Sierra Nevada of 4.1 to 8.5 per cent super-density lost from 7.4 to 23.4 per cent of normal of its water content. The cause of the super-density and premature runoff lay evidently in the lack of sufficient new snow during February-March to insulate the older snow against weathering and by its greater porosity to hold in suspension whatever water was formed by surface melting. The porosity of snow diminishes directly with its increase in density and when the density approaches maximum, as in the case of ice, its capillarity, or ability to hold water in suspension, is almost completely lost.

Effect of Area and of Water Content—The assumption that light snow melts, that is, loses its water content,, more rapidly than packed snow is yet to be proved, if similar areas of exposure and equivalent water content are considered. The only modification of this principle is that snow of light density does not attain the maximum density attained by snow initially much denser. However, this is a phenomenon of the close of melting rather than of its beginning. The effect of premature melting in distorting the forecast depends upon the relative area of the watershed below the line of the stable winter snow and upon the shallowness of its snow cover. The shallower the snow the more rapid its melting and the greater the area the more disproportionate its effect upon the forecast, which is based upon surveys in the deeper and stable snow.

Runoff in Central Sierra Quadrangle—This is strikingly demonstrated both in the Central Sierra and the Humboldt quadrangles. For example, in the relatively high basins of the West Walker, Lake Tahoe, Carson and Mokelumne the runoff fell below the "probable maximum" forcasted only 5 to 10 per cent and was practically identical with the "conservative estimate". But in the lower basins of the South Yuba and Truckee it fell from 15 to 22 per cent below the "probable maximum" and 10 to 17 per cent below the "conservative estimate". The greatest variation occurred in the basin of the Truckee, but the runoff of this stream has regularly been lower than the forecast, indicating that its normal is possibly too high.

The only doubt that can be thrown upon the above data is that the precipitation during April-June in the higher basins, as in the West Walker and the Carson, was considerably greater than in the lower basins. However, this is not true to the same extent of the Mokelumne and the Tahoe Basins, as of the other high basins in the quadrangle. Furthermore, all basins had an excess of precipitation during April-June. Consequently, the loss can be chargeable only to excessive melting at the lower levels of the various watersheds during March.

Runoff in Humboldt Quadrangle—Although no snow surveys were conducted in the Humboldt quadrangle on March 1 and consequently no exact data of the March melting were procured, the effect of premature melting at low levels on the runoff was even more pronounced than in the Central Sierra quadrangle. For the Humboldt River failed by 25.4 per cent of normal to attain the seasonal April-July runoff of 93.0 per cent indicated by the snow survey at or above the elevation of 7,000 ft. As a confirmation of this phenomenon, the runoff for April-May, which of necessity depends mainly upon the lower snow cover, was 39.0 and 44.0 per cent deficient respectively, while the deficiency in the runoff for June and July, which obviously depends upon the snow cover at high elevation, was only 4.9 and 9.1 per cent. A part of the deficiency in April-May may be due to shrinkage below diversions on the northern feeders, which were attaining their maximum runoff at this time but had a snow cover of only 82.9 per cent of normal as compared with the snow cover of 103.1 per cent on the later flowing southern feeders. In any case, the shrinkage should occur principally on the northern feeders, for here is situated by far the greater proportion of watershed.

The deficiency in runoff would doubtless have been even higher if the excess precipitation during April-June had not been so great. Owing to the relatively small area of snow cover remaining June 1, the extraordinary rainfall of June and the small excess above normal in July were not the main factor in causing the marked increase in runoff during June-July, even though the heaviest precipitation fell on the Ruby Range where the snow fields were widest. Otherwise, the heavy precipitation of April-May should have had greater effect in increasing the runoff. This factor can only have been the normal snow cover in the Ruby Range augmented by the heavy precipitation there, whose combined effect even thus scarcely counterbalanced the losses elsewhere due to premature melting during February-March.

Federal Aid Road Mileage

A total of 8,820 miles of federal-aid road was completed in the fiscal year which closed June 30, 1923, bringing the total of federal-aid roads completed to 26,536 miles. The mileage completed during the year is classified in the table given here. The projects under construction at the close of the year amounted to 14,772 miles and were estimated at 55 per cent complete. In addition to the 26,536 miles completed and the 14,772 miles under construction there were at the close of the year a number of projects approved but not yet placed under construction, the aggregate length of which was 6,917 miles.

	Miles		Miles
Graded and drained	1860.1	Bituminous concrete	76.8
Sand-clay	749.5	Concrete	1440.3
Gravel	3815.4	Brick	78.8
Waterbound macadam	335.6	Bridges	10.8
Bituminous macadam	452.9		8820.2

Building the Highest Hydraulic Fill Dam

Major Unit of New England Power System, Davis Bridge Development on the Deerfield River Near Readsboro, Vt.—Dam Is 200 Ft. High

By A. C. Eaton
Hydraulic Engineer, Power Construction Co., Worcester, Mass.

The Davis Bridge power development was described by Mr. Eaton in the issue of Jan. 24. This article continues the description of the construction operations on the dam.—Editor.

Elemental operations in an isolated place characterized the Davis Bridge power development construction. The 200-ft. earth-fill dam, the center of operations, is located about equidistant and some 25 to 30 miles from Greenfield, North Adams, Brattleboro, and Bennington, cities which could be used as supply bases. Readsboro and Wilmington, each with a few hundred inhabitants, are within about 10 miles by road. All roads are poor, however, and travel is slow, and this made it necessary to house and feed the workmen on the job. The first work preparatory to starting construction was, therefore, the erection of a 200-man camp in the fall of 1921. As the operations developed the Power Construction Co. completed top mess, office, storehouse and hospital, and water, sewerage, lighting and central heating systems and, in the late winter, increased the dining hall and bunk houses to 400-man capacity. During 1922 subcontractors built additional camps and the season of 1923 found seven camp units housing upwards of 1,200 men.

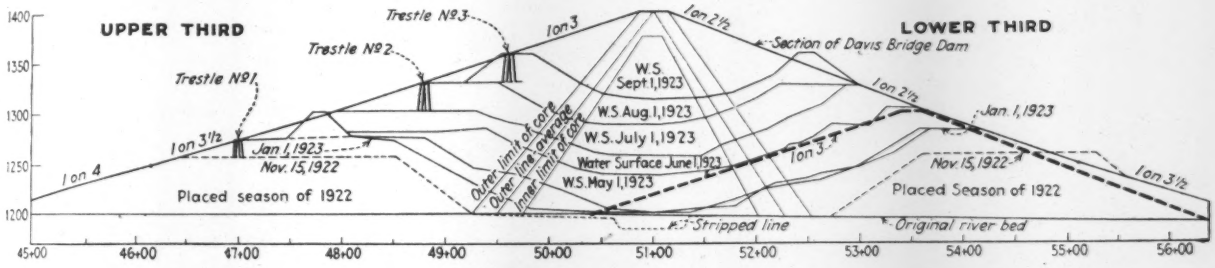


FIG. 1—DAVIS BRIDGE DAM SHOWING PROGRESS CROSS-SECTIONS

Diversion Tunnel Constructed in Seven Months—The first work was the diversion tunnel and it was sublet to the Rollin Construction Corp. in January, 1922. To get under ground with all possible speed, shafts were sunk at the portals, leaving the approaches to be cut out later. The spillway shaft was also excavated and work was carried on from here. As soon as space was available, a steam shovel operated by air was placed in each end. Muck was loaded into skips or trucks and hauled to the shafts by mules. The upper 300 ft. of the tunnel was through a glacial drift formation which had a marked tendency to slide bodily on the underlying ledge. This section was completely timbered; in the ledge section no timbering was required.

The ledge was hard and tough and broke larger than was convenient for handling so that the progress was less than was hoped for. The average rate was 31 ft. per heading for a 14-shift week. The rate in the earth section with hand mucking was 33 ft. per week; with shovel mucking 56 ft. per week. In the ledge section the rate with hand mucking was 16 ft. per week and with shovel mucking 35 ft. per week. The average in solid rock, per week per heading, was about 550 cu.yd.

Lining followed the excavation closely. Steel forms were used and the muck cars were operated through them. Concrete was mixed at a central plant, transported to the shafts by cars and dumped into hoppers. From here it was blown into the forms by air through a 6-in. pipe. This method caused a minimum interference with the mucking. Water was turned through the tunnel on Sept. 17, 1922.

For the final closure of the diversion tunnel the general program will be to pick a period when the water in the river can be held back by existing dams upriver and to erect a steel and timber bulkhead just upstream from the permanent plug where recesses were left in the lining. A 4-ft. cast-iron pipe will extend from this bulkhead through the area of the final plug. Water will then be taken through this pipe and the concrete placed in the permanent plug, through a vertical well-drill hole from the surface. Finally the gate at the lower end of the pipe will be closed and the reservoir allowed to fill.

Included with the diversion tunnel contract and the shaft was the ledge excavation for the spillway structure. First the shaft was sunk with the uniform diameter from the surface called for to give the finished diameter of 22½ ft. for the lower 100 ft. This lower section was concreted. A heavy platform was then placed on top of the lining and the upper 70 ft. was filled with muck. This gave more working space for track and operations in removing the 30,000 cu.yd. of ledge from the spillway area. When this was done the muck was removed from the shaft in steps which gave a working space at the respective elevations for the removal of ledge to form the mouth of the spillway shaft. This proved a very satisfactory way of handling the work. The curved forms were then made up for a quarter of the diameter and for the full 70 ft. height. They were used four times to complete the concrete work.

Dam Constructed at Daily Rate of 10,000 Yards—The dam, with 1,900,000 cu.yd. to be placed in less than two full working seasons, called for a dirt handling outfit

of real magnitude. The work was sublet to the W. F. Carey Co., Inc., in 1922. In June, the first dirt was placed in the dam and when the work closed down for the winter 500,000 cu.yd. had been placed (Fig. 1). Filling started again April 15, 1923, and on Sept. 1 the work was well ahead of schedule. During the three months of June, July and August, 750,000 cu.yd. were placed. A modified hydraulic fill method was employed. Material was loaded into dump cars by shovels at borrow pits and transported to the upper and lower sides of the dam where it was dumped from the dikes and sluiced down.

A method of raising the dikes from time to time, which was used in the construction of the nearby Somerset dam ten years ago, was to build trestles and then dump from them until they were full after which the fill would be widened by dumping and throwing track. At Davis Bridge the delay in completing the river diversion made it necessary to start placing material before trestles could be built. A log crib was built diagonally across the stream near the upstream toe and then extended near the left bank parallel with the stream some 300 ft. This crib diverted the river flow to the left bank and permitted the placing of considerable material in the upper third of the dam prior to river diversion. A shelf was cut along the right bank at an elevation about 50 ft. above the river and dumping started from this shelf was carried out until the toe of the slope reached the top of the crib. In a similar manner material was placed in the lower third of the dam, except that no crib work was used here but the material was allowed to crowd the river toward the left bank.

Had a good sized flood occurred during this period considerable material would have been lost. As the time for diverting the river approached a track was laid along the left bank of the river at an elevation of 50 ft. above the water and material was dumped towards the stream from this side, thus narrowing the waterway. On Sept. 17, 1922, the diversion tunnel was completed and the water was turned through it by closing the gap between the fills. This dike was quickly raised to the 50 ft. height. Water from a 750-gal. pump washed the material down the upstream slope as it was dumped and puddled it across the boulder-covered river bed. This gave a tight bank and no trouble was experienced from leakage through it. A 20-ft. trestle was placed on top of the closure dike and quickly filled, which gave sufficient height to force any probable flood through the tunnel, but no flood of sufficient size to test the tunnel capacity occurred during the construction.

As soon as the river was turned, a railroad-type shovel was placed in the bed to clean out about 5 ft. of boulders from the middle third. A small whirly (traction type) shovel was also set to work to dig the cutoff trench 50 ft. wide and about 16 ft. below the river bed. A cableway across the valley on the center line of the dam handled the skips from the deep trench, while the material from the big shovel was handled by 4-cu.yd. dump cars and a dinky to the lower third of the dam. A large dragline was used to advantage in cleaning up the middle third and digging the cutoff trench on the right bank of the river. Great care was taken in cleaning up the river bed and the middle third on either side. This was completed on Nov. 20, 1922, and a start was made on pumping water into the area between the two dikes. When the work closed down for the winter at Christmas, the water was at El. 1,223 and the core material was at El. 1,190 or about 6 ft. deep in the cutoff trench.

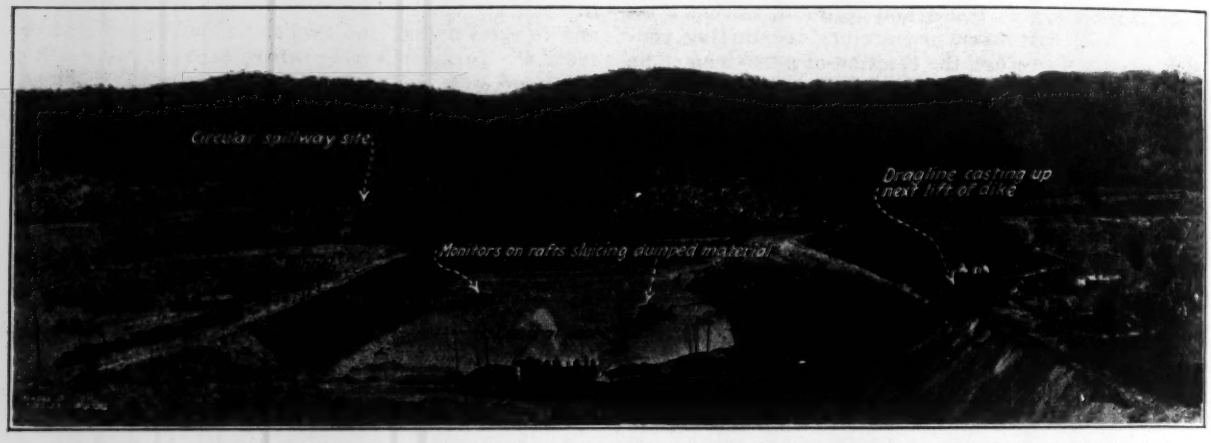


FIG. 2—VIEW SHOWING FILL AND CONSTRUCTION OUTFIT ON THE HIGHEST EARTH-FILL DAM

As laid out at the start of the work the progress schedule called for placing 670,000 cu.yd. of material in 1922. Because of the delay in diverting the river the dam work was handicapped so that the season ended nearly 200,000 cu.yd. behind schedule. The spring was late and the work again fell behind during April so that May 1 found a shortage of 230,000 cu.yd. At this time the schedule was revised and the construction plant increased to meet the new demand, with the result that on Sept. 1, the work was ahead of the revised schedule.

An interesting and satisfactory substitute for the dump trestles was developed. The contractors installed a large dragline for stripping work and the building of the dikes. This large dragline dug a pit alongside the dump track into which the trains could dump quickly. From this pit it handled the material into a dike extending some 30 ft. above its own working elevation. By working nights and days this machine has placed all but five of the dumping dikes. Five dumping trestles were built instead of 14 as originally contemplated. The top 16 ft. of the dam will be

placed with this machine. The flat slopes of the lower part of the dam and the wide dumps made the use of the dragline possible where steeper slopes and a dam of less height would have prohibited its use. Thus its use for the upper 100 ft. of the dam was possible only by placing considerable of the material outside the slope of the dam and rehandling the material by the dragline after the dike had been widened and the track thrown toward the pool. With the exception of the dragline work and the equipment required to feed it the placing of the material was a single 10-hour shift operation.

All sluicing was done by two 750-gal. pumps at 100 lb. nozzle pressure direct-connected to 100-hp. motors. Each unit was mounted on a raft in the central pool, and thus the water was used over and over. In addition a third stationary pressure pump furnished water to several fire streams which were used to good advantage in washing down material and thus providing free dumping space at track elevation. Makeup water was furnished by a pump of equal capacity set up at the edge of the river at the toe of the dam and operated as occasion demanded. Above a pool elevation of 1,310 little makeup water was required as the elevation of the pool was raised largely by the displacement due to the material washed in. This would indicate that the retaining dikes were very tight. Tests made during August showed that water thus sluiced carried about 9 per cent solids as it left the pumps.

Earth dam building is largely a dirt moving job requiring principally organization and equipment for that type of work, coupled with sound engineering judgment in the placing of material. Much credit is due the contractors on this work for their foresight in setting up and equipping the job and for the skill with which they carried out the work. Within a few days of the signing of the contract they had obtained and shipped to the work a number of old refrigerator cars which were quickly converted into living quarters for several hundred men. Track layout was made for the use of all standard-gage equipment. Borrow pits were opened up with long runs from the dam which permitted run-around tracks and great flexibility in the operation of the dump trains. Efficient track crews were organized which maintained the track in excellent condition and built track in new locations quickly as occasion arose. Approximately twelve miles of standard-gage track were required. The principal items of equipment were 15 locomotives; 102 12- and 16-cu.yd. dump cars, 6 railroad-type shovels up to 5-cu.yd. capacity, 2 whirly type shovels, a locomotive crane, a dragline, 3 sluicing pumps and adequate machine shops and repair equipment for maintenance work. The season of 1923 required a crew of 500 men.

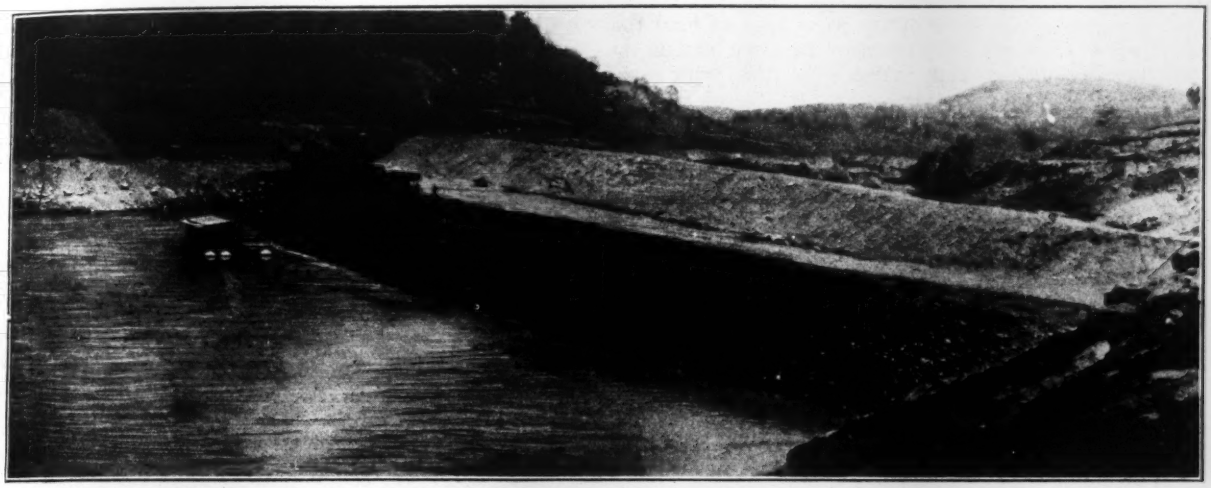


FIG. 3—THE SLUICING RAFT AT WORK IN THE POOL

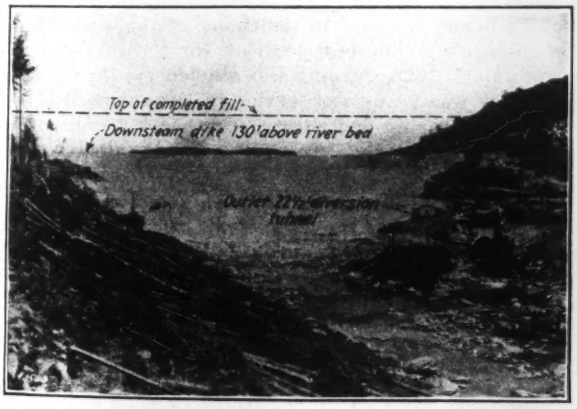


FIG. 4—DOWNSTREAM ELEVATION OF DAM WITH DIKE 130 FT. ABOVE RIVER BED

Power Tunnel and Control Structures—The contract for the power tunnel, and excavation and concrete work for control structures, was let to the Mason & Hanger Co., Inc., in July, 1922. The job was laid out with compressor plant and blacksmith shop at each end and one at the adit which was at the halfway point. Work was carried on at four headings in two shifts per 24 hours, each shift mucking, drilling and blowing. The top heading and bench method was used, the bench closely following the heading work.

The alignment of the river made attractive an adit at the halfway point of the tunnel from which work progressed in two directions. This adit was driven about 6x8 ft. and was 800 ft. long. The muck as it was removed from the adit was crushed and stored for use in the concrete lining. The lining was not started until the excavation was completed. Steel forms were

used in sections 150 ft. long. Concrete was placed directly in the invert; the side walls and the arch roof were placed with air.

The job started out as a hand-mucking job but due to labor difficulties a Hoar mucking machine was placed in each heading after about four months' operation. These machines materially cut down the labor requirements but did not improve progress as the rock had a tendency to break too large for the speedy operation of the machines. The final solution seemed to be a combination of hand and machine mucking to give the best progress. The average rate of progress in all headings was 9.2 ft. per heading per two-shift day. The average rate including only shifts worked was 11.5 ft. In general, storage battery locomotives were used to haul the muck cars, although supplemented to some extent by gasoline locomotives and mules. As the work progressed a ventilating system using reversible rotary blowers and spiral riveted pipe was installed.

The surge tank base was excavated from solid ledge. A plate steel, 90-deg. bend, 10 ft. in diameter, connects the middle of the bottom of the tank with the tunnel lining extended. A trench was excavated for this pipe and after it was assembled in position it was embedded in the foundation concrete. The holes for the 3-in. anchor bolts were drilled 8 in. in diameter with a well drill and to a depth of 14 ft. Surge tank steel erection was started Sept. 1 by the Riter-Conley Co. The surge tank connection, the plate steel tunnel lining and the penstocks were furnished and erected by the Lancaster Iron Works, Inc.

Power House Construction—Substructure and penstock excavation was started in the fall of 1922 and in the spring of 1923 the concrete had been brought up to a point just below the bottom of the plate steel scroll cases to furnish working space for erecting the cases. While this was being done the outside of the substructure was carried up to the main floor and the superstructure steel was erected. This work has been carried out by L. H. Shattuck, Inc.

The scroll cases were assembled with the speed ring and then in order to test them before concreting a temporary sealing ring was substituted for the gate mechanism. The butterfly valve was placed in position at the entrance to the scroll and calked with lead from the inside to make it tight against reverse pressure. This allowed the case to be filled with water and tested to a pressure of 260 lb. A 30-gal. triplex pump was used to furnish this pressure. Minor leaks occurred around the rivets but were calked with no trouble and the whole case made tight at the test pressure. After being tested the cases were embedded in concrete and the rest of the wheel and generator assembled. It is the writer's opinion that scroll cases of heavy plate construction which are too big to be shipped assembled should be shipped in advance of substructure construction and assembled on skidways adjacent to the work. This should greatly reduce the interference with the progress of the work on the power house structure.

Existing Railroad Relocated—A construction item of considerable proportions and yet only incidental to the main project was the relocation of 8 miles of the Hoosac Tunnel & Wilmington R.R. This railroad crossed the dam site on the east bank about 30 ft. above the water and followed the river along the east bank through the length of the basin. Surveys extending over nine months finally resulted in the choice of the west side of the reservoir as the best location for the railroad, and about Jan. 1, 1923, grading was started for the roadbed. The track was ready for service in December, 1923.

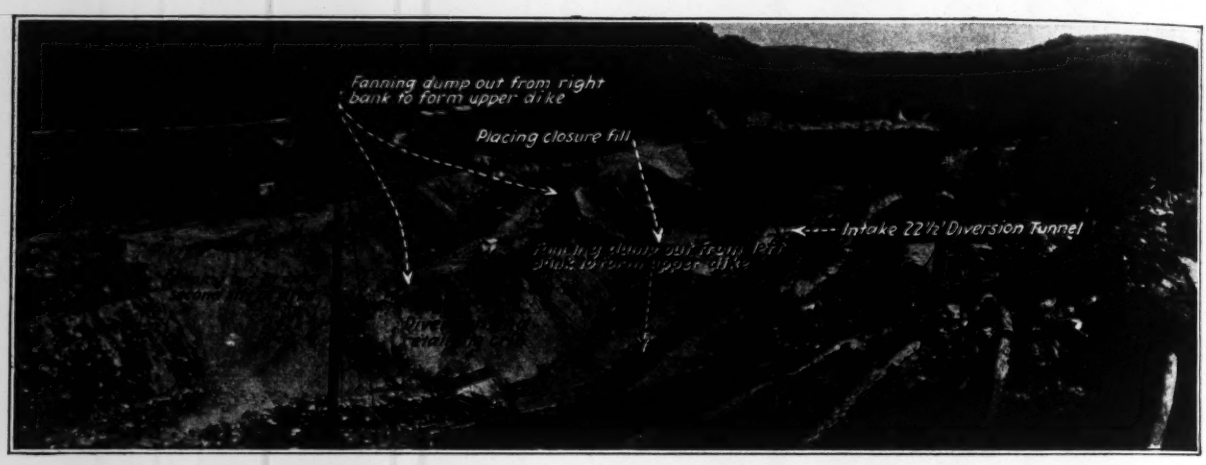


FIG. 5—NEAR THE END OF THE FILLING OPERATIONS ON WORLD'S HIGHEST EARTH DAM

The engineering and construction work for the whole project is under the supervision of the Power Construction Co., a subsidiary of the New England Co. The J. G. White Engineering Corp. acted as consulting engineers. Some of the main items of the project were sublet as noted elsewhere, but all other items as the transmission line, the railroad relocation, highway relocation, clearing of the reservoir area, building and operation of camps, and many minor items, were handled directly by the company's own forces.

B. & O. Will Electrify Staten Island Lines

Official advice has been given this journal that, although the exact character of construction is not finally determined upon, the Baltimore & Ohio R.R. Co. expects to undertake the electrification of its lines on Staten Island in the near future. The first section to be undertaken will be the St. George to Tottenville and South Beach line of the Staten Island Rapid Transit, and will involve an expenditure of approximately $6,000,000.

Reinforced-Concrete Hotel Under Construction Fails By Progressive Collapse

Eight-Story Benton Harbor Structure Completely Wrecked By Slow Failure Continuing 30 Hours After Removal of Fifth-Floor Shores—Cause Not Yet Determined but Materials and Cold Weather Suspected

By T. L. Condron
Of Condron Co., Engineers, Chicago

AN EIGHT-STORY reinforced-concrete building under construction in Benton Harbor, Mich., failed on Jan. 28-30, the collapse continuing during 30 hours and ending up in the complete wrecking of the structure, leaving only a few short lengths of column standing. The structure, which was to be the Hotel Vincent, had been started late in November and was nearing completion.

On Monday, Jan. 28, shoring was removed from the fifth floor. In the night the fifth floor began to fail; about midnight the three west central bays of this floor fell, and by morning these three bays had collapsed from the eighth floor to the ground. From this time on, the collapse of the structure progressed during the entire day, and by the morning of Jan. 30 the entire building was a complete wreck except for a small two-story portion in the rear.

So far as I know, this is the most complete collapse of a multistory concrete building that has occurred. In this particular it surpasses the record of the collapse of the Masonic Temple at Salina, Kansas, July, 1921 (*Engineering News-Record*, Sept. 15, 1921, p. 432), though in financial loss the latter was three or four times greater than the Benton Harbor disaster even though all of the Salina structure did not collapse.

Through the courtesy of the architect, Mr. Nicol, of the firm of Nicol, Scholer & Hoffman, and William Bastar, manager of the Benton Harbor Hotel Co., the writer was given every assistance in making an inspection of this wreck for *Engineering News-Record*.

Slow Collapse—The accompanying photographs tell the story more vividly than words. Fig. 1 is a photograph taken ten days before the disaster, when the seventh floor had been poured, and shows the sixth story inclosed with tarpaulins. On Jan. 24 part of the eighth floor was poured, and on Jan. 28 this floor was completed. A few hours later the fifth floor began to fail.

The photograph Fig. 2 was taken at 9 a.m. on Jan. 29, and shows the appearance of the building that morning, with a great gash down the center of the west or Sixth St. face of the structure. By noon of that day this gash had deepened from one panel to a depth of two panels in this width of three bays. About noon the columns of the south side, along East Main St. began to fail, and that entire frontage, seven bays long, for a depth of one panel, collapsed from top to bottom, as shown in Fig. 3, taken at 1 p.m. Another view, taken at 4 p.m., does not show any further collapse, but the gradual disintegration continued after dark and during the night, so that by 9 on the morning of the 30th the collapse was complete, as shown by the photograph Fig. 4. This view was taken before the work of clearing up the wreckage had been started, although to look at it one might think that several weeks had elapsed between the two views Figs. 3 and 4, instead of 20 hr., mostly night-time.

Structure of Building—The floor plan of the building was L-shaped above the third floor. The building stood on a lot 100 ft. square and the lower two stories covered the entire area of 10,000 square feet. Above this the rear corner, 56 x 56 ft., was open, so that the higher part of the building had 100-ft. frontage on each of the two streets and 44-ft. depth, giving a floor area above the second floor of approximately 7,000 sq.ft. The typical framing plan of the fourth to eighth floors is shown in Fig. 5. The construction of this building followed the common form of this type of buildings, with square columns connected by deep longitudinal

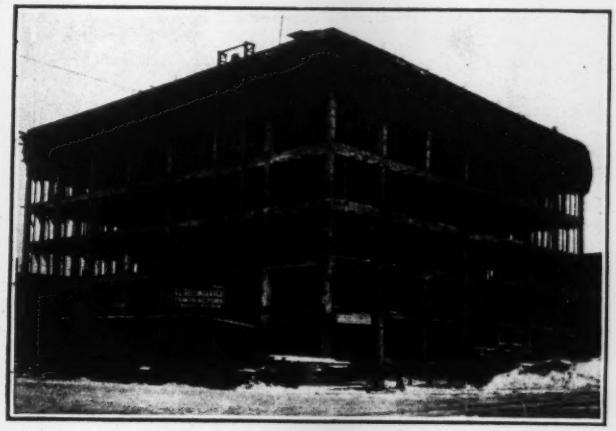


FIG. 1—HOTEL VINCENT UNDER CONSTRUCTION
View taken Jan. 18, ten days before failure.

girders in each of the two long dimensions. It will be noticed, of course, that only two of the wall columns on the two street fronts have girder connections. The wall columns were simply rodded columns, while the interior columns were reinforced with spirals as well as vertical rods. The rodded columns have square ties of ¼-in. rounds spaced about 12 in. apart.

Time has not permitted me to make an analysis of any of the stresses in this frame, but, of course, the final analysis must take account of the structural design, including the determination of the strength required for all parts of the structure, before one could say whether every part was adequately designed for its proposed load and duty. It seems, however, that in this case the concrete itself, rather than the structural design, is most at fault.

The appearance of the wreckage is in general that of trash rather than concrete. It will be observed from the photograph Fig. 5 that relatively few structural parts, such as columns and beams, are in evidence. The wreckage is being cleared up not with blocks and tackle raising large masses so much as with picks and shovels. Much of the debris is simply loose stone and sand that can be shoveled and carted away. Even when columns are intact a few blows of a sledge disintegrate them, and the reinforcing bars are stripped out without much difficulty. There is much evidence pointing to complete failure of the mixed ingredients

to combine to form concrete, as might follow from lack of sufficient cement, or bad cement, or even very bad aggregates, or "cold weather conditions," including freezing.

Materials—The fine aggregate on the ground at present is a very fair quality of sand, which on looking at and handling seems clean and good. It will be submitted to laboratory tests. The crushed stone "ranges from fine to coarse." There is a good deal of "fine" and all of the stone has crusher dust adhering to it. It is, of course, damp or frozen and there is no chance for the dust coating to fall off. However, the stone seems to be quite up to the usual quality delivered on scores and hundreds of jobs in this region, and I would expect it to give good results if properly mixed with suitable proportions of sand and cement. I do not think anything was attempted in the way of scientific grading. It was the usual 1:2:4 mixture.

The water used was the regular city water, and we do not expect bad results to follow using Lake Michigan

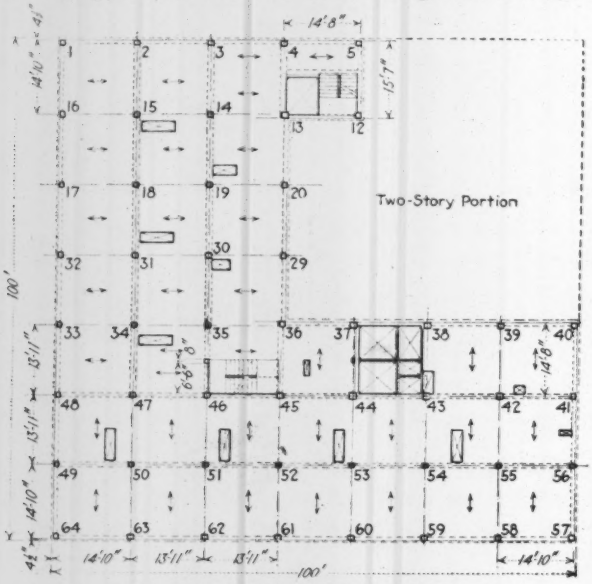
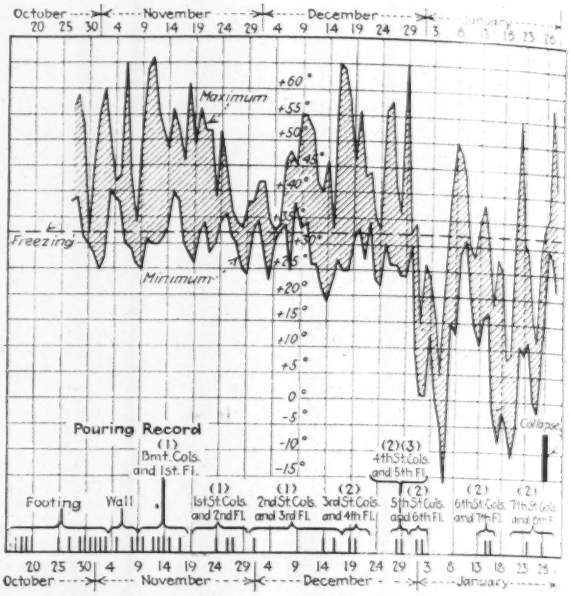


FIG. 5—PLAN OF UPPER FLOORS

water. The inspector states that after Nov. 9 they used calcium chloride in all concreting, using 16 qt. of the crystals or flakes of the calcium chloride to each barrel of water. This calcium chloride would delay freezing, but I am not certain that it would insure setting of concrete with materials so cold that the resulting mixed concrete would have a temperature below 40 deg. F., as it probably would have, notwithstanding that "the water was all heated," according to the inspector.

Regarding the cement, no tests were made by or for the owner. It was bought under a specification requiring it to have the qualities called for by the "A.S.T.M.," but there would seem to be reasonable question about whether it had these qualities. The cement was furnished by a local dealer, and the brand was "Michigan portland cement" said to have come from the Chelsea plant, which plant has been recently taken over by the state for roadway work. Some bags of this cement, delivered for the eighth floor, are still on hand and samples have been taken for testing. When a shortage of cement occurred on the job, the dealer made up the deficiency by sending "Alpha" to fill out, and there seems to be a feeling that this was better than the "Michigan" brand. No tests have been made to demonstrate this feeling.

Cold-Weather Precautions—The job was a cold-weather job from the start. The diagram Fig. 6 is a chart of maximum and minimum temperatures taken



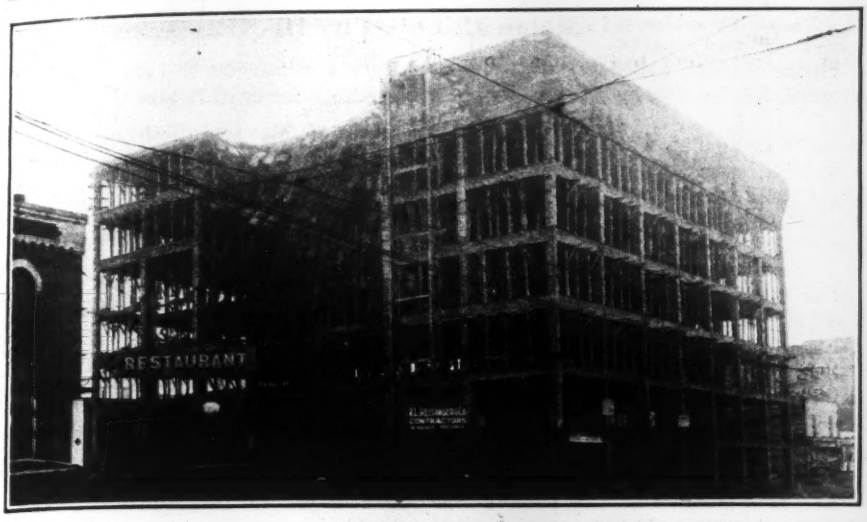
(1) Water heated.
(2) Water and aggregates heated by steam jets, also 16 salamanders used under floor and story below enclosed by tarpaulins, calcium chloride used.
(3) Forms under 5th floor removed Jan. 28. Collapse started at 5th floor 9 p.m., Jan. 28, and completed 12 p.m., Jan. 29

FIG. 6—TEMPERATURE RECORD DURING CONSTRUCTION

From recording thermometer on south wall of News-Palladium building, a few blocks from the hotel.

from the autographic records of a recording thermometer located about three blocks away from the hotel site on the south wall of the Benton Harbor *News-Palladium*, the leading newspaper of the city. The location of this thermometer is such that it is probable that the "maximum temperatures" are somewhat higher than the general atmospheric maximum temperatures. It will be noted that the daily minimum temperature throughout the months of November, December and January, with two exceptions, were below 40 deg. F., and during January, with one exception, were below 30 deg. F. On eleven days in January the minimum was down to zero or lower, reaching on one day —16 deg. F. The fifth floor, where failure first began, was poured on Dec. 28 and 29, when the minimum temperature was 24 deg. F., followed almost immediately by two severe cold waves, with minimum temperatures of 2 deg. F. and —16 deg. F.

According to the statements of the contractor's superintendent and the architects' superintendent, the same precautions against cold and freezing were taken with all work above the third floor; namely, heating the water and aggregates by means of live steam jets and a gas torch in the mixer, enclosing with tarpaulins the story below the floor being poured and keeping fires in sixteen salamanders in this enclosed story for three days. After this period, the tarpaulins and salamanders were moved up one story.



FIGS. 2 TO 4—PIECEMEAL COLLAPSE OF HOTEL VINCENT FRAMEWORK DURING THIRTY HOURS, JAN. 28 TO 30

Fig. 2—At 9 a.m., Jan. 29, three bays on the west face had fallen, the collapse beginning about twelve hours earlier. On Jan. 28 the fifth-floor shores were taken out.

Fig. 3—By 1 p.m., Jan. 29, the entire south front was down, for a depth of one panel. The collapse on the west side also progressed inward during the latter part of the morning.

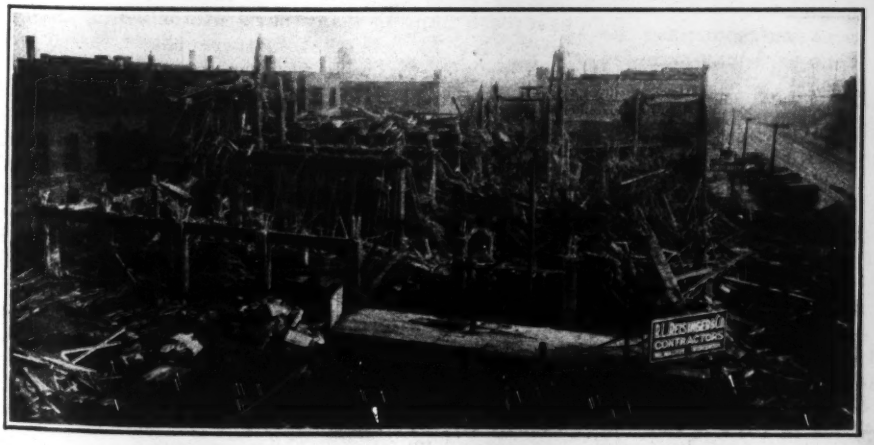


Fig. 4—View taken 9 a.m., Jan. 30. Failure was complete by midnight of Jan. 29. By morning only a few lengths of column sticking up out of the debris were left.

The fifth floor and fourth-story columns were poured on Dec. 28 and 29. While the concreting was progressing on the eighth floor, on Jan. 28, the shoring under the joists of the fifth floor was removed, leaving shoring in place under the girders.

The floor construction was a 2-in. concrete slab with concrete joists 6 in. deep and 5 in. wide spaced 25 in. center to center. The reinforcing of the 2-in. slab was ¼-in. rounds spaced 18 in. apart (temperature bars). Each rib was reinforced with one ⅝-in. square bar, straight, and one 1¼-in. round bar bent to pass over intermediate girders. The span of these joists was approximately 14 ft. center to center of supporting girders.

In general, the wall columns were 18 in. square in the basement and first story, 16 in. square in the second and third stories, 14 in. square in the fourth and fifth stories, and 12 in. square above. The reinforcement varied from twelve vertical bars (8.73 sq.in.) in the first story to four vertical bars (1.0 sq.in.) in the seventh and eighth stories. The wall columns supporting the fifth floor were reinforced with ten vertical bars (6.0 sq.in.). The bars were placed 1½ in. from the face of the columns and were held by square ties made of ¼-in. rounds spaced not more than 12 in. apart.

If the danger line for concrete and construction is the temperature at which water freezes, namely 32 deg. F., then the precautions taken on this work would seem to have been adequate up to and including the fourth floor, but experience and tests all point to the fact that the critical temperature for concrete work is considerably above 32 deg. F. When the temperature falls below 45 deg. F. it is important to exercise unusual care in concrete work, including heating of materials, and adopting measures which will make certain that the concrete work is kept above a temperature of 50 deg. F. for a sufficient number of days to insure the setting up of the concrete.

Summary—On the face of it, this disaster appears to be due to cold-weather conditions, notwithstanding the precautions which the contractor states he took to protect the concrete; but, as previously stated, there is a question as to the quality of the cement. I have no way of knowing, except by the statements made, whether the amount of cement specified was used in all cases. It was specified that the columns should be 1:1½:3 mix and the floor structure 1:2:4. The work was constantly under the supervision of a graduate engineer, and there is every reason to believe that the specifications were carried out as intended.

Reisinger & Co., Milwaukee, were contractors for the building. The work was being done on a maximum-fee basis.

Fourth Conduit Being Built from Thirlmere

The fourth water supply conduit from Lake Thirlmere to Manchester, England, was about half completed at the close of 1923, according to the London *Engineer*. The conduit is 54 in. in diameter and will have a total length of about 32.3 miles. Of the portion thus far laid 9¾ miles are of steel and 4¼ miles are of reinforced concrete, Bonna system, and ¾ miles of concrete-lined cast iron. Most of the pipe is "laid on concrete, and where the ground is water-logged" is laid on "reinforced-concrete rafts and either partly or entirely surrounded with concrete." The contract for the work was let in 1922. It should be completed in 1925.

Melan Honored by His Colleagues

Meeting in Honor of 70th Birthday of Noted Professor of Bridge Construction

ON THE occasion of his seventieth birthday, on Nov. 18, 1923, a group of colleagues and former students of Prof. Joseph Melan, of the Prague Technical College, celebrated the event by a meeting in honor of his long service to the engineering profession and in recognition of his help and stimulus to them. Because of Prof. Melan's pioneer work in bridge and concrete construction, a short summary of the biographical account prepared for that celebration is reproduced here through the courtesy of Dr. August Nowak of Prague and Gustav Lindenthal of New York.

Joseph Melan, was born in Vienna in 1853, was graduated from the Vienna Technical College in 1876. He early inclined toward the academic career, and became assistant at the college first to Dr. Winkler, professor of bridge and railway construction, and later to Dr. Rziha, professor of railroad construction. At the same time he found opportunity for practical work in the bridge works of Ignaz Gridl at Vienna, where among other work he dealt with the project for the Donau-Moldau canal and the bridge across the Danube at Cernavoda, Rumania.

PROF. JOSEPH MELAN, OF PRAGUE

In 1886 he became professor of mechanics and graphic statics at the Bruenn Technical College, where eight years later he succeeded Brik as professor of bridge construction. He left Bruenn in 1902 to take the chair of Steiner as professor of bridge construction at the Prague Technical College, where he has remained.

While Melan has been connected with many important pieces of work—among them recalculation of the Williamsburg bridge over the East River for the Department of Bridges of New York City in 1902, and analysis of the design of the Hell Gate bridge in 1906—he is perhaps most widely known for his achievements in reinforced concrete. He introduced the widely known "Melan System" of reinforcement in 1894. A great number of bridges and other structures of this type have been built in many parts of the world, and it is interesting to note that most of them, except those built in America, were designed by Melan himself. A number of his bridge projects were honored by prizes.

His technical writing covers a wide field. From 1880 to 1891 Melan edited the "Zeitschrift des oesterreichischen Ingenieur u. Architecten Vereines." Beginning in 1876 he has published a very large number of papers and articles, dealing with steel and concrete bridges, bridge theory, economics and details, as well as with studies and descriptions of specific structures. His work on the theory of suspension bridges has received perhaps widest circulation. This appeared originally in the "Handbuch der Ingenieurwissenschaften," but was made more readily available to American readers by "Theory of Arches and Suspension Bridges," a translation by Dr. D. B. Steinman, published in 1913.

Lethbridge Northern Irrigation District in Alberta

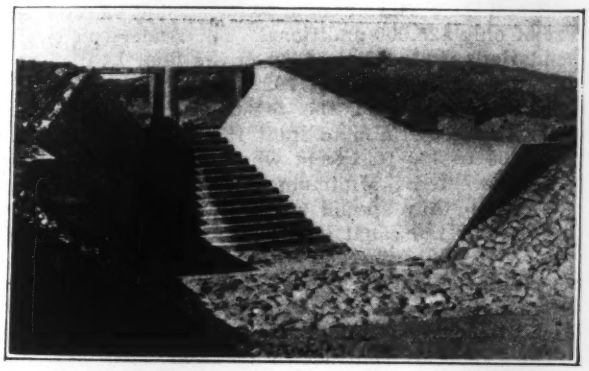
Provincially Backed Bonds Finance Canadian Enterprise—Internal Storage Found Cheaper Than Large Canals—Controlled Hydraulic Jump Utilized in Grade Reduction Drops

BY C. M. ARNOLD AND H. G. COCKRANE
Principal Assistant Engineer and Engineer of Structures, respectively, Lethbridge Northern Irrigation District, Lethbridge, Alberta

IN SOUTHERN ALBERTA, Canada, north of Lethbridge is an irrigation project of 210,000 acres (104,758 irrigable) representing the last of three phases of irrigation development which run parallel to those experienced in the United States. Rosy expectations of individual and partnership schemes, followed by corporation developments in which the expected profit failed to materialize, finally led to government co-operation, with district bonds carrying provincial guarantees, and to construction carried out under "The Irrigation Council."

In carrying out the work a close study was made of water duty, rainfall and runoff with a spillway for one flood per 100 years. The cost of a storage reservoir midway the length of a long main canal was balanced against that of a larger canal. Protection of concrete structures against alkali was provided and creosoted wood-stave siphons were used. As the country slopes rapidly, a special investigation of drops finally led to utilization of the hydraulic jump and to simplify construction drops were confined to two or three equal heights of same design.

The project comprises 53 miles of an 800-sec.-ft.



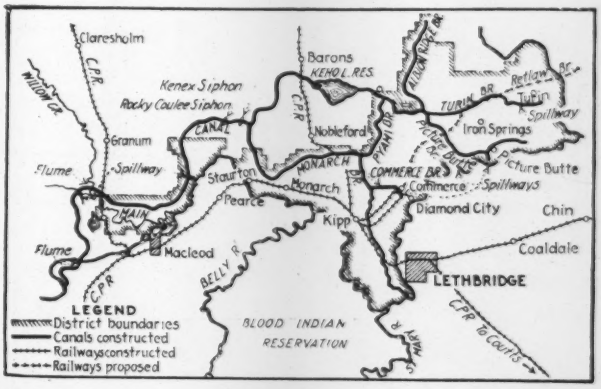
HYDRAULIC JUMP DROP FOR GRADE CORRECTION
Typical 5-ft. grade correction of the controlled type with steps in chute pointed downstream at center to spread water to sidewalls to avoid concentration of energy at center which would defeat object of jump.

main canal, 64 miles of branch canals and 454 miles of distribution ditches. Structures of note include the headworks on Old Man River, a low diversion dam with sluice and regulator gates, two flume stream crossings, two 10½-ft.-diameter wood-stave pipe siphons and three plate girder railway bridges over the principal canals.

Water Supply—A careful study of the water supply available was made based on records of the Dominion Hydrometric Department which extend over a period of ten years. All calculations were based on the water available in 1910, the year of lowest recorded flow up to 1916, the year the study was made. On the hydrograph of the year 1910 were plotted the requirements according to the assumed seasonal demands based on practical irrigation experiences in this locality. The demands in southern Alberta are light at the beginning of the season, May 1, increasing to a maximum in 35 days, then decreasing. The average depths which are required on the land are assumed to be as given in the following table:

May 1 to June 10	4.4 in.
June 10 to July 15	7.0 in.
July 15 to Aug. 20	4.4 in.
Aug. 20 to Sept. 30	2.2 in.
Total	18.0 in.

Duty of Water—The approved duty of water on which the design was based was as follows: (1) A net duty of water of 1.5 acre-feet per acre per season measured at



LETHBRIDGE NORTHERN IRRIGATION DISTRICT SHOWING LOCATION OF STRUCTURES ON CANAL SYSTEM

the farm weir. (2) An irrigation factor of 80 per cent (1.5 acre-feet on 80 per cent of the irrigable area being equivalent to 1.2 acre-ft. on the full irrigable area). (3) That 50 per cent of the total irrigable area may require an irrigation 6 in. deep within a period of 15 days.

In this section the average annual precipitation for the eighteen years from 1902 to 1919 was 15.6 in. and the average rainfall during the cropping season, May to September, of ten of those years when there was less than 13 in., was 7.3 in. The total precipitation for 1915 and 1916 when good crops were secured without irrigation was 13.6 and 18.3 in., respectively, for the months of May to September inclusive.

Soil—Soil samples were taken over the whole irrigable area and tested for alkali in the field with the electrical bridge and where more than moderately strong alkali was indicated the samples were sent to Ottawa for chemical analysis by Dr. F. T. Shutt, Dominion chemist. The areas considered unsuitable were excluded.

Canal Design—The maximum irrigation requirement fixes the net capacity of the canals at 1 sec.-ft. per 120 acres of irrigable land, based on the entire irrigable area. For canals carrying less than 50 sec.-ft. an additional capacity was provided to allow for a rotation system of delivery with a minimum irrigating head of 2.5 sec.-ft.

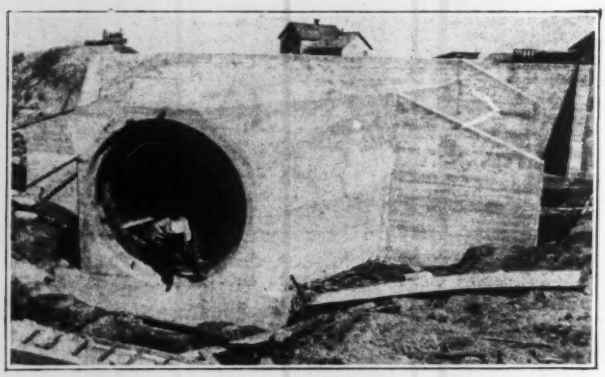
As far as practicable the canal sections were designed according to the formula $b = d^n - dh$, in which

b = bed width, d = depth of water and h = side slope ratio. Cross-sectional area is thus equal to the cube of the depth at full supply. On the main canal the lower bank was made 12 ft. wide on top to secure greater strength where needed and provide sufficient width for a roadway for use in inspection rounds of the operating staff. On branch and secondary canals the lower bank was made three-fifths the bed width and the upper bank two-thirds the width of the lower. All canals and ditches have been constructed with a bank on each side except on contour locations on comparatively steep side hills where a lower bank only has been built. Freeboard in all cases has been made half the depth with a maximum of 3 ft.

Rate of grade in all cases was made such that the velocity would not exceed 2.8 ft. per second, and where necessary drops were introduced to secure this.

Except on the main canal, where absorption losses are assumed to be taken up by surplus in Keho Lake reservoir, an allowance of 6 cu.ft. per second per million square feet of wetted area has been added to the capacity of all canals and ditches to cover these losses.

For canals and ditches of 8-ft. bed width and less, the value of "n" has been taken at 0.025 and for those



CONCRETE PORTAL OF WOOD-STAVE SIPHON
Transition from rectangle of canal to circle made by "quarter cones" inserted in the angles of the rectangle. Little head is lost.

over this size at 0.0225, Manning's discharge formula being used throughout.

Where the canal is built entirely in fill, the embankment has been constructed with an excess of strength. The outer slopes vary from 1½:1 to 3:1, so that the slope of the plane of saturation, assumed at 3½ horizontal to 1 vertical drawn from the water surface outward, will not intersect the outer slope nor approach the toe nearer than approximately 10 per cent of the base width.

Cross drainage has been provided by the installation of corrugated-iron culverts placed 2 ft. below the canal bed and provided with rubble masonry portals. A siphon spillway with a capacity of 300 sec.-ft. is located at Sta. 72 below the intake; a combination spillway and cross drainage culvert at Kuishap Creek, mile 13, has a capacity of 600 sec.-ft., and a controlled spillway was built at mile 28 with a capacity equal to that of the main canal.

The location of the main canal for the first 4 miles is on the south or east side of Old Man River. The canal then crosses by flume to the opposite side. This location instead of the apparently natural one on the north and west side of the river was dictated by topographical conditions, the north and west sides of the valley containing long stretches of high cut banks on which it is impracticable to build a canal. Further the necessary added length of line required if the intake were placed upstream at a sufficiently high elevation to get the canal above these cut banks and back on the prairie bench would have cost several times as much as the flume crossing of the river in the adopted location.

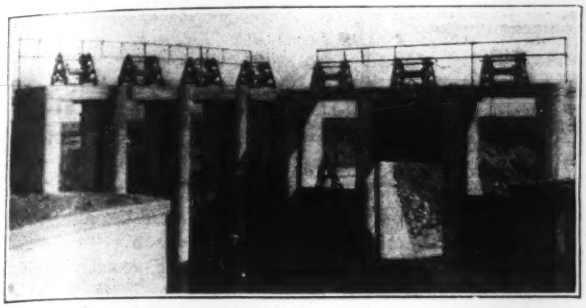
Keho Lake Reservoir—The main canal into and the Turin branch out of Keho Lake reservoir were constructed according to the original location as first projected by the Dominion Irrigation Department. This department later, in 1916, changed the plan on account of the heavy work of cutting into and out of Keho Lake, proposed to abandon the lake as unnecessary and to change the location of that portion of the main canal east of Kenex to that which is now occupied by the Monarch branch and its contour extension, the Piyami branch, allowing sufficient additional capacity throughout its length to provide for absorption losses for the whole system.

After the formation of the district in 1919 the Provincial Government secured a complete report on the project from George G. Anderson, Los Angeles, Calif., who recommended the inclusion of the reservoir in the system. He pointed out that with it included the absorption losses in the main canal could be neglected and he estimated that by thus reducing the capacity of the main canal from 1,086 sec.-ft. to 800 sec.-ft. the saving would practically offset the heavy work and the reservoir could be included at an estimated cost of only $28,000 additional. Mr. Anderson's recommendations were followed when the final location surveys were undertaken in 1920.

In the location of the principal canals it has in general been the aim to limit the length of curves to from 200 to 300 ft. except where extraordinary conditions prevented. Minimum radius of curvature was not fixed by any special rule but was never less than three times the canal bed width. The location levels were thoroughly checked by from three to four independent lines and permanent bench marks of ¾-in. iron 5 ft. long were set with the tops a little below ground level, placed every mile, and carefully referenced.

The general contract for excavation, involving 6,300,000 cu.yd. of material, of the canals and ditches for the whole system was let June 1, 1921, to Grant Smith & Co. & McDonnell, Ltd., of Calgary and Vancouver, and was completed Oct. 19, 1922. The work was carried out by a force which at its maximum consisted of 600 teams, 2 steam shovels and 5 dragline machines. The team outfits used either elevating grader and dump wagons or three- or four-horse fresnos. The dragline machines varied in size from those with 1½- to 2½-yd. bucket and 60-ft. boom to a dragline with a 4-yd. bucket and 100-ft. boom used on a heavy cut that was 38 ft. deep and very largely solid rock.

Protection Against Alkali—The structural work for the headworks and canal structures required 26,000 yd. of concrete. In view of past experience in the destruction of concrete from alkali action all possible protective measures were taken. The specifications required very careful grading of fine aggregate to ensure a dense concrete. All aggregate was washed, separated and recombined in proper portions, mixing water was tested with the Jackson turbidometer and no water containing more than 150 p.p.m. of sulphates was permitted



HAND-OPERATED BRANCH CANAL HEADGATES
Four openings control the flow in the main canal and three the discharge into the branch canal.

to be used. The slump test was used throughout the work as a guide for consistency. Test cylinders were broken at frequent intervals and always showed excellent results. The back of all retaining walls was waterproofed with two coats of asphalt dissolved in a volatile flux which was sprayed on through a nozzle under a pressure of about 75 lb. per square inch. Weepholes were provided in walls at floor level and a reversed gravel filter was placed between the wall and the refilling

Headworks—At the site selected for the intake the river is divided into two channels. During the low stages little or no water flows in the west channel. The diversion works consist of a regulator, scouring sluices, a log pass and a low ogee weir. The greater part of the weir, which is 524 ft. long, is across the island and the west channel and a considerable part of its crest length is actually lower than the existing surface of the ground on the island. It is intended that during the early years of operation the discharge over the weir will be controlled by sandbag or gravel embankments so as to direct the flow over those portions of the crest now on the island and in the west channel and thus scour out much of the island below the weir. Normally at extreme floods the weir would be more or less drowned, but by the proposed control the retrogression of levels below the dam will be accelerated and the depth on the crest reduced. In this way the backwater effect caused by the weir will be materially shortened and the control of gravel and silt bars, which tend to form above any fixed weir, rendered much simpler. To facilitate this control the weir is divided by piers into five equal openings, spanned by footbridges for access to the west side. The only other means of crossing are found 9 miles below and 22 miles above the site.

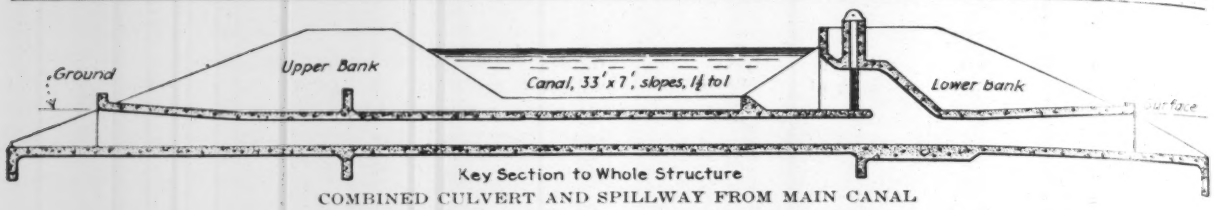
Adjoining the weir is a 30-ft. opening for passing logs, and between it and the regulator are the three scouring sluices, each with a 26-ft. clear opening. All four openings are closed by Stoney gates lifting 21 ft. by means of worm gears and counterweights, to clear the estimated maximum flood level.

The maximum flood discharge to be provided against was a matter of considerable study. Records were available beginning with 1910—too short a time to be a reliable guide in estimating. By the formulas developed by Weston E. Fuller (Trans. Am. Soc. C. E., Vol. 77, p. 564) a flood discharge of 40,000 sec.-ft. once in 100 years would appear probable. By plotting on probability paper, after the manner suggested by Allen Hazen, in a discussion of the same paper, a flood of 40,000 sec.-ft. would appear possible once in a period of 300 years. Considering the short time for which records were available, it was thought wise to design against a possible flood of 40,000 sec.-ft. Such a flood would just cover the whole valley floor, even without the weir. The weir will result in an afflux of about 3 ft. at this discharge and consequently to prevent outflanking it was necessary to build a flood embankment over a mile long and to a maximum height of 20 ft. The fore apron is carried downstream for sufficient length to insure that even at flood stages the locus of the hydraulic jump will not be beyond the downstream edge of the fore apron. The depth of the cutoff walls, which are entirely in gravel, is governed by the necessary length of path of percolation. The regulator is at right angles to the crest line of the dam and is divided into four 10-ft. openings, closure being made by Stoney gates.

Spillways—Owing to the fact that at flood stages in the river the regulator discharges as an orifice, the fluctuations in water level in the forebay, which may occur at night or when no attendant is at hand, might cause an overload on the Old Man flume, which is 4 miles downstream. As a safety valve a siphon spillway is built at Sta. 72 on the main canal, automatically to take care of such fluctuations. From a study of the past records of the river it appeared possible that the variations in water level in the forebay during a period of 12 hours might result in an increase in canal discharge of about 450 sec.-ft. Such an increase piled on the normal full supply of 800 sec.-ft. would result in overflowing the steel flume at the river crossing. The spillway was therefore designed with a capacity of 300 sec.-ft. continuous flow. It will act intermittently with an overload of about 180 sec.-ft. (Trans. Am. Soc. C. E. Vol. LXXXV, p. 1129.)

INTERSECTION OF WOOD AND STEEL TRESTLE FOR FLUME OVER OLD MAN RIVER
The K-brace design of timber trestle permits piecemeal replacements.

The canal is carried over Old Man River in a semi-circular steel flume 3,300 ft. long. The shell is of 14-gage copper-bearing sheet steel, with a 1½-oz. zinc coating. The first 800 ft. is carried over a bench on timber trestles from 11 to 20 ft. in height, of K-brace design adapted to timber construction. This design of

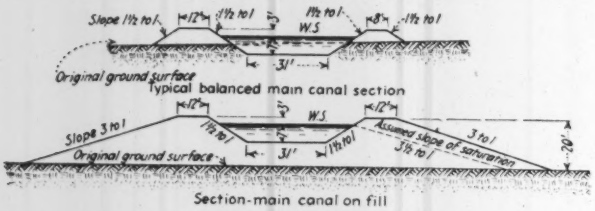


COMBINED CULVERT AND SPILLWAY FROM MAIN CANAL

trestle was chosen principally in order to permit piecemeal replacement. The next 1,700 ft. is carried on steel trestles, 32 ft. in height, supported on concrete pedestals whose minimum height is 6 in. above the maximum estimated flood level. The river channel is spanned by seven 120-ft. steel truss spans supported on concrete piers whose footings are carried from 12 to 14 ft. below the river bed to a sand-rock foundation.

The inlet and outlet reinforced-concrete portals are designed for minimum entry, transition and exit losses. The canal ends of both structures are rectangular but are warped to a semicircular section at the flume ends by means of "quarter cones" in the angles between the floor and side walls. It so happens that the calculated normal flow in the flume is uncomfortably near the critical depth, so that a check might result in the water "slopping over" the sides of the flume shell. The structure involves 4,000 cu.yd. of concrete and 540 tons of structural steel, not including the steel shell.

Culverts—In the next 12 miles of canal three underpassages provide for cross drainage, one of which at mile 13 has a catchment area of 65 sq.mi. At this point provision is made for spilling 600 sec.-ft., or 75 per cent of the full canal capacity, through the canal bank into the culvert barrels, closure of the spillway being effected by two timber gates of Stoney type, lifted by ordinary



TYPICAL SECTIONS OF MAIN CANAL

hand winches. This point is the last opportunity for a spillway until the Hollandale spillway is reached at mile 29.

Willow Creek, at mile 16, with a calculated maximum discharge of 9,000 sec.-ft., is crossed by a flume 800 ft. long, of similar section and design to the Old Man flume, but with three 80-ft. steel truss spans across the channel.

At mile 29 (the Hollandale spillway) a set of regulating gates can divert the full canal discharge into a short spillway channel 600 ft. long. There are four openings on the main canal and two on the spillway channel, closure being made by timber Stoney gates 6½ ft. wide and 7 ft. high, lifted by ordinary chain winches. The spillway channel discharges into a deep coulee by means of a reinforced-concrete chute. The inlet end is a notched control section with 1 to 1 sides and a bed width of 9½ ft. This width is carried to the lower end without change, the side walls being reduced in height toward the bottom. Some trouble is anticipated at the lower end of the chute from cutting back, but as the spillway is only for occasional use, suitable protection is being left as a maintenance job.

Siphons—At miles 38 and 40 there are two wood-stave pipe siphons, 10½ ft. in diameter, exactly similar except for length, the former being 2,855 ft. long and the latter 930 ft. long. The pipe is built of creosoted Douglas fir staves, 5½ in. thick, banded for a maximum head of 45 ft. with eight ⅞-in. bands in the 5-ft. space between each pair of cradles. The timber cradles are supported on concrete blocks, the foundations of which are from 2 to 3 ft. deep. Each siphon is provided with a 12-in. blowoff. All four concrete portals are alike in design. The cross-sections at the junction with the canal are rectangular and at the junction with the pipe are circular, the transition being made by "quarter-cones" inserted in the angles of the rectangle. This gradual transition results in little lost head at entry and permits recovery of much of the velocity head at exit. Siphons were used at these points on account of the saving in cost over flumes, as it was found that a large percentage of the flume trestles would have been too high for economical construction in timber, necessitating the use of steel at a probable cost 15 per cent greater than for the siphons.

Keho Gates—The discharge from Keho Reservoir is controlled by a structure consisting of a bulkhead counterfort wall across the canal which at the site of the structure is in a cutting 25 ft. deep. Three openings, 6 ft. wide by 8 ft. high, are closed by Stoney gates of steel which are counterweighted and raised by worm gears through three separate towers on the downstream side of the bulkhead wall. The openings lead to three 6 x 8-ft. barrels, 75 ft. in length, which are covered by a 16-ft. earth fill with a 30-ft. roadway across the top. The head against the structure will be 25 ft. with reservoir full. One roller curtain of I-beams and timbers is provided for emergency closure of any opening.

Grade Correction Works—One consequence of the steep slope through which most of the distribution system is built is the unusual number of grade correction works; in fact a very large proportion of the total masonry and timber built into the system has gone into structures of this character. With a view to reducing these quantities (and the consequent cost) to a minimum, an exhaustive study was made of all the various types which have hitherto been used or proposed. The type which promised the minimum cost for a given discharge and height of fall consisted of a closed channel with contracted inlet and expanding outlet in which advantage could be taken of atmospheric pressure to induce very high velocities, and consequent high friction losses. By introducing two right-angle bends of very short radius, the further advantage of the high friction losses in such bends would be obtained, and the total head lost in the structure could be adjusted very closely to the total height of fall. This type of structure, while very promising in reduction of cost, was abandoned on account of the possibility of blocking by debris—a serious matter in a country as badly

infested with drifting tumble weeds as this will be for some years to come. Moreover it is not easy to design the type for efficient action at partial supply without involving manual control.

The type finally adopted depends for its efficient action on the deliberate formation of the hydraulic jump. Selection of this design would hardly have been possible prior to the researches of the Miami Conservancy District, and it is desired to give the fullest possible credit to these pioneers and also to Julian Hinds whose articles (see *Engineering News-Record*, Nov. 25, 1920, p. 1034, and Dec. 23, 1920, p. 1223) have been of the greatest benefit in these studies.

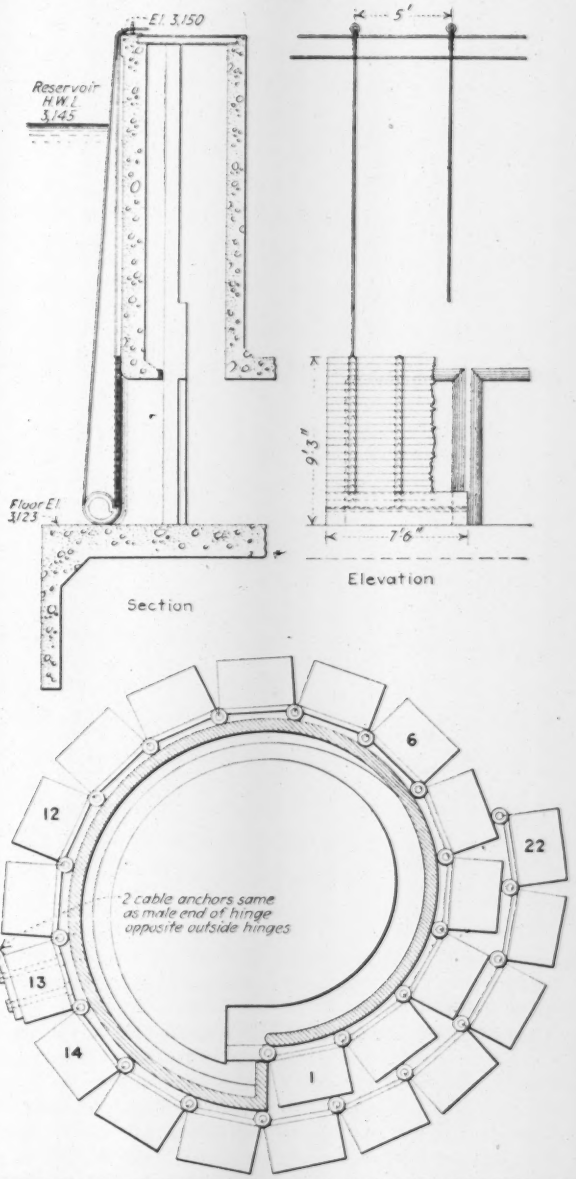
In any canal grade correction work three features are essential to efficient operation: (1) To prevent undue acceleration in the canal above the work, or rather to confine the acceleration where it can do no harm; (2) to transfer the water from the high to the low level with the least damage to the structure; and (3) to discharge the water into the lower reach with as much as possible of the energy dissipated.

The great difficulty hitherto has been to comply with the third condition. In an ordinary straight overfall with or without a water cushion, the water issues from the structure with a great deal of the energy, released by the fall, still potential of damage. Although the mean forward velocity at the exit may be no greater than in a normal reach of the canal, there is nevertheless an abundant store of kinetic energy at work in the form of eddies and whirls and the great bulk of this non-apparent energy is expended in digging holes in the bed and banks for a long way downstream. Niagara furnishes a first-class large-scale illustration of this phenomenon.

The conditions on which the design of the chute depend are: (1) That the splay of the side walls should not exceed about 26 deg. from the center line; and (2) that the grade of the floor should not fall below the curve of free discharge at any point. The floor of the chute is corrugated or stepped to give increased frictional resistance, the treads of the steps being slightly pointed downstream at the center line to assist in spreading the water out to the side walls in its descent, and thus avoid concentration of energy at the center, as this would defeat the object of the jump.

Having designed the chute, the surface curve is then calculated and plotted by taking sections at intervals of from 2 to 4 ft. Knowing the depths and velocities at these various sections and the depth of tail water in the canal below the drop, the "locus" of the theoretical jump can be determined diagrammatically (see diagram 44 in bulletin on "hydraulic jump," Technical Reports, Part III, published by Miami Conservancy District). The actual length of jump has been found experimentally to be from six to eight times the theoretical height, two-thirds of the jump length occurring downstream from the theoretical position.

Similarly for any stage of supply the locus and length of jump may be determined and a curve of loci plotted. These calculations determine the necessary length of side walls beyond the foot of the chute, which in practice should be built slightly longer. The side walls are returned into the side slopes of the canal, riprap being added below for a distance of from 10 to 16 ft. depending on the discharge and the height of fall. It is impossible to determine the exact length of protection necessary and it is probable that some further riprap will be required later on, especially in the lighter soils. The thickness of the side walls as built varies from 7 to 10 in. This thickness is determined by constructional reasons rather than by conditions of stability or strength. Thinner walls would mean little,



EMERGENCY CURTAIN FOR TWIN BRANCH HEADGATES

if any, saving on account of the added difficulties of properly tamping the concrete in the forms and preventing the earth slope from caving into the mix while pouring.

In the construction the earth slopes were trimmed to exact outside dimensions and the sloping wall forms then set, braced together and weighted with rock.

Floors and walls were reinforced by 6 x 6-in. square No. 6 wire mesh, placed in the center of walls and on the top of floors. Weep-holes and a reversed filter layer under the downstream floor and chute are provided to prevent uplift pressure.

Considerable study was made to determine what

heights of falls for various groups of drops would give the minimum total construction cost. In order to save as much as possible in formwork it was desirable to have groups of drops as nearly alike as possible. A given total grade compensation may be divided between as many separate works as necessary. By making the works all alike a great saving in formwork is possible. Estimates of cost for a run of heights were made and the profile of the canal was adjusted to give the minimum total cost for structures and excavation together. It was not economical to make all the drops on any given stretch of canal alike in height, but it was possible to confine them to two or three selected heights which secured at least part of the advantage of uniformity.

Lethbridge Works Tested by Double Expected Flood —During the summer of 1923, shortly after the completion of the Lethbridge headworks, there was encountered in the Old Man River a flood more than double the amount allowed for, as estimated from the meager runoff data available.

H. B. Muckleston, until recently chief engineer and project manager, describes as follows the effect of the flood upon the headworks and upon canal and spillway.

"The Old Man River has been subject to an extraordinary flood. The works which were designed to pass

GRADE CORRECTION, 7½-FT. DROP PASSING 200 SEC.-FT.

OVERTURNED SIPHON SPILLWAY, LATER JACKED TO PLACE AND UNDERPINNED

40,000 sec.-ft. actually passed 88,000 sec.-ft. without damage to the structure. The flood broke into the canal below the diversion and did an immense amount of damage to the canal. The siphon spillway was outflanked and turned over, but has been righted and jacked back into place. Ninety feet of the steel trestle was carried out at the flume crossing of the Old Man River, owing to a wide alteration in the river channel. The accident occurred in spite of the elaborate precautions taken against this very thing. This combination of disasters has prevented much water being run during the season of 1923. Fortunately the rainfall was much above the average during the season so that the loss of water has not been the disaster it might have been."

H. B. Muckleston, who recently resigned to enter private practice, was chief engineer and project manager and C. M. Arnold is principal assistant engineer in general charge of all location and construction work in the field. H. G. Cockrane is engineer of structures. Location surveys, earthwork and timber construction were in charge of divisional engineers F. S. Dyke and P. M. Sauder.

Test Floating Roofs for Oil Tanks

EVAPORATION and fire tests of floating roofs for oil tanks were recently made by the U. S. Bureau of Mines and have been reported upon by Ludwig Schmidt of the Bureau. This type of roof (Wiggins) was described in the Equipment and Materials section of *Engineering News-Record*, Nov. 15, 1923, p. 826. The first tests were made to determine the evaporation loss which will occur at the narrow joint space between the periphery of the floating roof and the side of the tank. This space is not over ¼ in. wide on the average. Laboratory tests of compartments of different widths, from ⅛ in. to 1½ in., formed in a sheet metal tank, showed that gasoline (of 57.7 deg. A.P.I. gravity) is subject to more rapid evaporation per square inch of surface the wider the compartment. It was calculated from the results that a 30-ft. tank with a ¼-in. peripheral joint exposure would lose 2.32 gal. in six days. A direct measure of the value of the floating roof in preventing evaporation loss was obtained by comparative tests of two 1,250-bbl. tanks, gasoline of 63 deg. A.P.I. being pumped from one to the other and returned a number of times. One tank had a floating roof and the other an ordinary fixed roof, and in each run the loss was measured. During the filling of an ordinary tank the air in the space above the gasoline, saturated with gasoline vapor, is driven out, and in emptying the tank a corresponding amount of gasoline is evaporated to saturate the incoming air, which is lost on the next filling; this loss is avoided in the case of the floating roof. The loss with the floating roof was 0.4 bbl. per 1,000 bbl. pumped, while that with the ordinary roof was 1.7 bbl. per 1,000 bbl. pumped.

To test the fire safety of a floating roof several tests were made with an oil fire burning on the roof of the tank or flame brought into contact with the vapor in the opening between the shoe and the tank shell. In the most severe tests, 5 gal. of gasoline were poured on the floating roof of a 30-ft. tank and ignited. The fire burned for a little over 15 min., flames constantly licking over the sides of the tank. In several places around the shoe the exposed gasoline caught fire and burned for about 5 min. after the gasoline on the roof was consumed, but was readily extinguished by cooling the hot shell of the tank shoe and tub of the roof. This test roof had a seal of flexible asbestos fabric instead of an oil seal. The test showed that the fire hazard of an oil tank is greatly reduced by a floating roof.

Experience and Test Results in Wood Preservation

Notes from Wood Preservation Meeting—Adding Petroleum to Creosote—Pole Perforation—Hot Zinc Chloride Treatment

NEW developments in wood-preserving practice were brought out in a number of the papers and committee reports presented to the American Wood Preservers' Association at its Kansas City meeting, Jan. 15-17. The principal facts brought out are briefly summarized in the following:

Creosote-Petroleum Treatment for Ties—Petroleum admixture with creosote for treating railway cross-ties has been experimented with to some extent as a substitute for coal tar admixture, which latter began on a large scale in 1908 because of shortage of creosote oil. The principal trial of petroleum admixture was made by the Santa Fe in placing in track 1,000,000 ties in Texas, New Mexico, and Arizona from 1909 to 1914.

The committee which studied the use of petroleum states that petroleum residue of proper grade fulfills admirably the requirements for use with creosote. A proper petroleum-creosote solution enters readily into the timber during the treating process. The petroleum should preferably be of asphalt base, but an oil of mixed paraffin and asphalt base may be used if it mixes well with the creosote without forming more than 1½ per cent sediment. It should have 225 deg. F. minimum flashpoint in a closed tester, and a viscosity not too high for proper penetration. The preservative effect of a proper petroleum-creosote treatment is satisfactory.

Petroleum may also be added to zinc chloride, and tests show that under most conditions it will add to the service which is obtainable from straight zinc chloride.

Preservation of Poles—The first inspection of a test lot of 350 creosoted poles placed in 1920 in an electric line between Kansas City and Olathe, Kans., showed that the pressure treatment used in preserving them was thorough and effective. The poles were treated part green and part air seasoned, the green poles being steamed during the treatment. They are exposed partly in moist and partly in dry soil. Excavation around the bases of the poles showed sound wood with a hard surface at the ground line, free from decay. The average penetration of the preservative was 2½ in., the depth of the sapwood.

Effect of Perforation During Treatment—After thirty months' observation of creosoted wood which has been perforated during treatment to produce deep saturation, a committee reports that the perforation treatment not only prevents harmful checking, but tends to close checks which are in the timber at the time of treating. Even without use of preservative, perforation seems to reduce checking, in fact to a greater extent than preservative impregnation without perforation.

Hot Zinc Chloride Treatment—From a study of hot zinc chloride treatment a committee finds that heat is of value in zinc chloride treatment somewhat as in creosote treatment. High solution temperatures are effective in improving the absorption and penetration, according to experiments by the Union Pacific R.R. They also shorten the time of treatment and therefore reduce the cost of operation.

Sodium Fluoride Indicators—Various tests for sodium fluoride penetration were investigated by George T. Parker and H. A. Geaque, of Lombard College, Galesburg, Ill. The best test for laboratory use is the following: The face of the wood cross-section to be tested is first sprayed with a 5 per cent solution of potassium ferrocyanide and dried, and then sprayed with a 5 per cent solution of iron ammonium chloride. As soon as the line dividing the treated and untreated portions appears, the sample is washed with water. The untreated part of the wood is colored deep blue. The line appears in about three or four seconds. The test should be performed in ordinary daylight, not in direct sunlight. It works equally well on pine, oak and fir. Claims for this test are that it is the only permanent test yet advanced, that it is easier to make than other tests, and that it uses more stable solutions and cheaper materials.

Steam and Vacuum Treatments—R. M. Wirka carried on a long series of experiments on the effect of variations in steam and vacuum treatment, at the Forest Products Laboratory, Madison, Wis. The material was Southern pine of pole or pile size, cut to 40-in. length, the bark being removed. Internal temperatures were measured in a central thermometer hole.

Steaming for 4, 6, and 8 hr. respectively at a pressure of 20 lb. per square inch, followed by a 20-in. vacuum for 3 hr., showed highest internal temperature for the longest time of steaming; no severe checking occurred and no through checking in any of the specimens. Six hours steaming at pressures of 20, 40, and 60 lb. respectively, followed by 2 hr. vacuum, showed highest interior temperature for the highest steam pressure, but after the vacuum treatment the internal temperatures were in inverse order of the steam pressures; this may have been caused by transfer of heat through checks, as the high-pressure specimens checked severely, though no through checks occurred, as shown by testing with air applied to the thermometer well. Vacuum periods of 1, 2, 3, and 4 hr. respectively, following 6 hr. steaming at 20 lb., showed that the reduction of moisture increased with the length of vacuum; the internal temperatures were irregular.

Tests to determine the time at which an internal temperature of 212 deg. F. is reached at various depths from the surface, under 20 lb. steam pressure treatment, showed that for radial distances of 2.5, 3.5, 4.5, and 5.5 in. respectively, the required steaming time was 5.7 hr., 6.3, 7.0, and 9.4 hr. Another series of tests showed that the internal temperature became equal to the mean temperature after periods of 17 to 22 hr. for radial distances of about 3½ in. and 38 hr. for a radial distance of 5½ in. No distinct advantage of the long over the short steaming period was noted insofar as loss of moisture and final temperatures are concerned. The long steaming produced through checking.

Effect of Hydrocarbons in Oils—Hydrocarbons have been found to give a higher toxic effect in wood-preserving treatment than other compounds. Further study of this subject by Ernest Bateman and C. Henningsen, of the Forest Products Laboratory, dealt with twelve hydrocarbons derived from coal tar or petroleum oils. It was concluded that hydrocarbons of the paraffin series are probably more toxic than the aromatic compounds of the same number of carbon atoms, but are generally too slightly soluble in water to be of value.

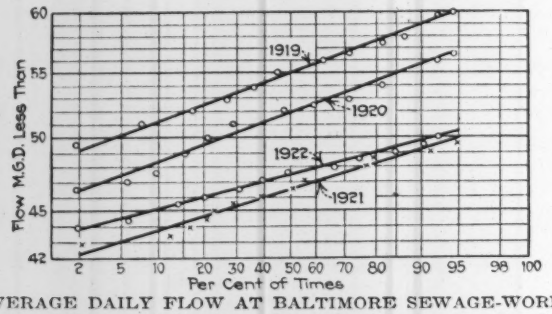
Operating Results of Baltimore Sewage-Works, 1919-22

Graphical Presentation on Probability Paper of Range and Frequency of Chemical and Bacterial Data Obtained

By C. E. Keefer
Assistant Designing Engineer
Sewer Division, Highways Department, Baltimore, Md.

THE STUDY, classification, and correlation of the chemical and bacterial analyses made at a sewage-works as large as the one at Baltimore have many possibilities. Whipple has pointed out that averages are often misleading and frequently do not give a true picture of the results. ("The Elements of Chance in Sanitation," by Prof. George C. Whipple, *Journal Franklin Institute*, July and August, 1916.) When a large number of analyses are considered, however, the average should be of value even though there are other more complete ways of depicting the results. In this study most of the results of routine analyses at Baltimore made during the four years 1919 to 1922 are presented graphically together with the daily sewage flow. Except for the final group of curves all the results have been plotted in terms of range and frequency, to show which the Hazen logarithmic probability paper used throughout is well fitted. Most of the analyses were made in accordance with the A.P.H.A. Standard Methods, 1917.

Method of Sewage Treatment at Baltimore—Before discussing the analytical results obtained at the Baltimore plant, a brief description of the type of treatment is desirable. The raw sewage upon entering the plant passes through bar gratings, where a portion of the



AVERAGE DAILY FLOW AT BALTIMORE SEWAGE-WORKS
Shows range and frequency for each of four years, based on the average daily flows for each week.

coarse suspended matter is removed. The sewage then flows through plain settling tanks with an average detention period of about 3.5 hours. From the settling tanks it passes through a series of revolving drum screens to the trickling filters. The chief purpose of the screens is to prevent the nozzles on the filters from becoming clogged. The trickling filters are 8.5 ft. deep and consist of 1- to 2½-in. trap rock. The average yearly rate of filter dosage varied between 2.79 and 2.91 m.g.d. in the four-year period, 1919 to 1922. After leaving the filter, the sewage flows through two final settling basins to its point of disposal in Back River.

Average Daily Sewage Flow—In 1919 (see diagram) the sewage flow was at its highest in the history of the disposal works. From 1919 to 1921 there was a gradual decrease in the flow due to a decrease in the water consumption by the city. Although the sewage flow for 1922 was slightly greater than for 1921, it was nearly 14 per cent less than in 1919. The combined result of these two conditions produced a sewage much stronger in 1921 and 1922 than in 1919.

Diagrams Showing Analytical Results—Analyses of the raw sewage, the settled sewage and the trickling filter effluent are compared graphically in two sets of diagrams, one presenting curves by individual years and the other the same data for the whole period. For suspended solids only two curves are given for raw sewage and for final effluent, the latter being the secondary or final settling tank that receives the flow from the trickling filters. There is no determination of suspended solids for the filters.

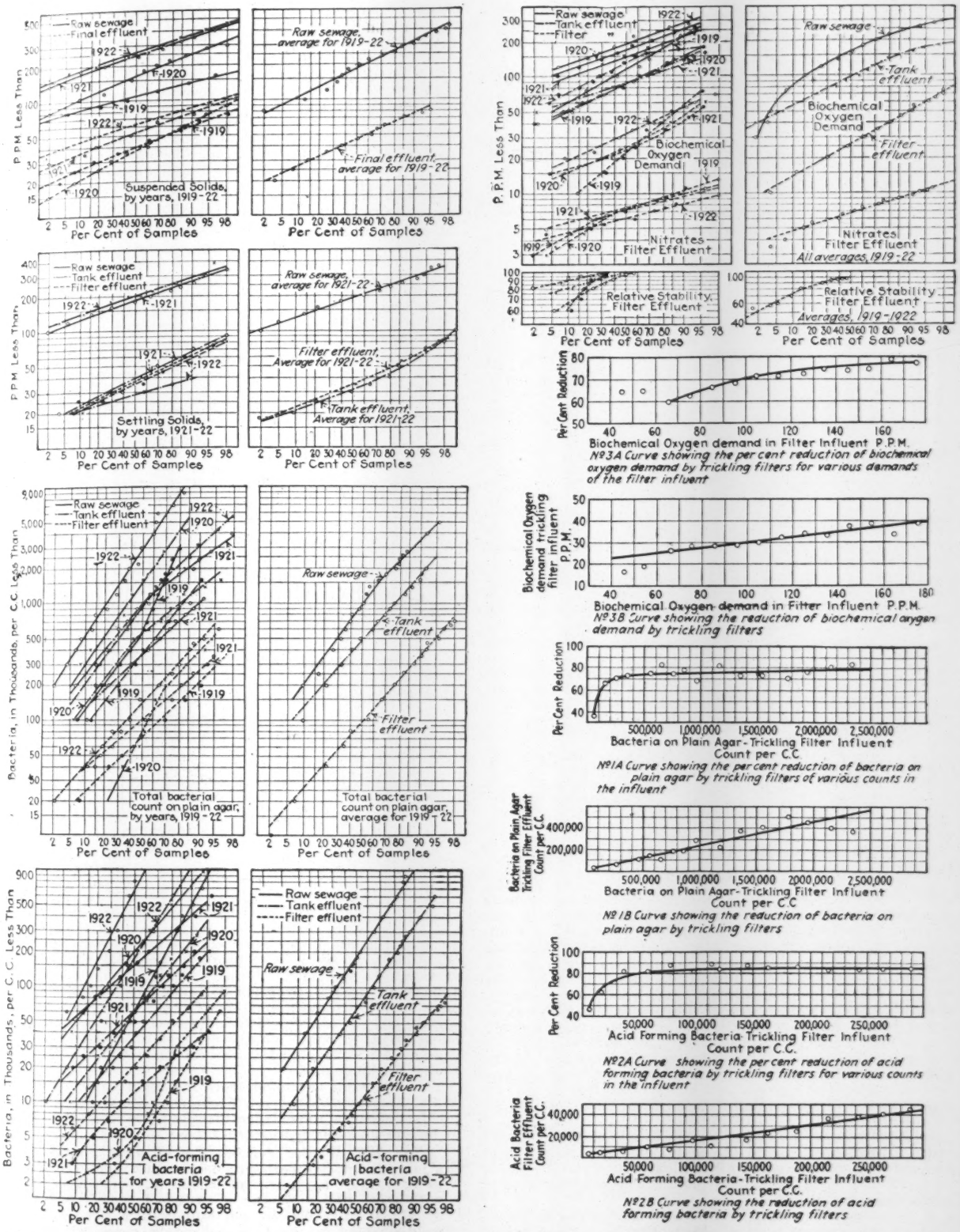
Performance of Trickling Filters—The degree to which the bio-chemical oxygen demand and the bacteria are reduced in the sewage by trickling filters is a matter of interest to sanitary engineers. Is the per cent reduction of the bio-chemical oxygen demand the same regardless of the oxygen demand of the influent to the filters? In other words, if the bio-chemical oxygen demand is reduced from 100 to 30 p.p.m. for one kind of sewage, will a bio-chemical oxygen demand of 200 p.p.m. be reduced to 60?

To answer this question a study of the bio-chemical oxygen demand of the influent and the effluent of the trickling filters was made for the years from 1915 to 1922 inclusive. If several analyses of the bio-chemical oxygen demand of the influent and the corresponding values of the effluent are plotted, the points will not be grouped so as to form a regular graph, but will be scattered about in a haphazard fashion. However, if an average is calculated for those analyses which fall within a narrow range together with an average of the corresponding analyses of the effluent, the points will fall along the line indicated on the diagram. This is designated as the "normal performance curve."

No effort has been made to express this curve by a formula, as the number of samples in its upper and lower ranges is comparatively few. When additional analyses of weaker and stronger sewages are determined, a further study of this curve will then be made and the formula for it deduced. It is possible that it will take the form as given by the formula $y = x\ k$. The corresponding per cent reduction curve has been plotted. This curve shows that as the bio-chemical oxygen demand of the sewage increases the per cent reduction also increases. Between a range of 65 to 175 p.p.m. in the influent the per cent reduction increases from 60 to 78.

Bacteria Removal by Trickling Filters—The same method was followed in studying the reduction of the number of bacteria by the trickling filters, using the counts on plain agar and also counts of acid-forming bacteria. Both of these curves show that as the bacterial counts in the influent increase the per cent reduction increases. It is apparent that the per cent reduction of bacteria on plain agar is less than the per cent reduction of the acid-forming bacteria.

Steuart Purcell is chief engineer of the Department of Public Improvements. The sewage-works is under the supervision of B. L. Crozier, highways engineer, and M. J. Ruark, division engineer of sewers. Prof. J. H. Gregory is the consulting engineer for the sewer division. The analyses used in preparing this paper were made under direction of T. C. Schaetzle, then principal sanitary chemist. Acknowledgments are due to Abel Wolman, chief engineer of the Maryland State Department of Health, who offered valuable suggestions in the preparation of the study.


Raw sewage
Final effluent
Suspended Solids, by years, 1919-22
Raw sewage, average for 1919-22
Final effluent, average for 1919-22
Per Cent of Samples
P.P.M. Less Than
Raw sewage
Tank effluent
Filter effluent
Settling Solids, by years, 1921-22
Raw sewage, average for 1921-22
Filter effluent, Average for 1921-22
Tank effluent, Average for 1921-22
Bacteria, in Thousands, per C.C. Less Than
Total bacterial count on plain agar, by years, 1919-22
Total bacterial count on plain agar, average for 1919-22
Acid-forming bacteria for years 1919-22
Acid-forming bacteria average for 1919-22
Raw sewage
Tank effluent
Filter "
Biochemical Oxygen Demand
Nitrates
Filter Effluent
Tank effluent
Filter effluent
All averages, 1919-22
Relative Stability, Filter Effluent
Averages, 1919-1922
Per Cent Reduction
Biochemical Oxygen demand in Filter Influent P.P.M.
Biochemical Oxygen demand trickling filter influent P.P.M.
Bacteria on Plain Agar-Trickling Filter Influent Count per C.C.
Bacteria on Plain Agar Trickling Filter Effluent Count per C.C.
Acid Forming Bacteria-Trickling Filter Influent Count per C.C.
Acid Bacteria Filter Effluent Count per C.C.

Nº3A Curve showing the per cent reduction of biochemical oxygen demand by trickling filters for various demands of the filter influent

Nº3B Curve showing the reduction of biochemical oxygen demand by trickling filters

Nº1A Curve showing the per cent reduction of bacteria on plain agar by trickling filters of various counts in the influent

Nº1B Curve showing the reduction of bacteria on plain agar by trickling filters

Nº2A Curve showing the per cent reduction of acid forming bacteria by trickling filters for various counts in the influent

Nº2B Curve showing the reduction of acid forming bacteria by trickling filters

RANGE AND FREQUENCY OF CHEMICAL AND BACTERIAL OPERATING DATA, BALTIMORE SEWAGE-WORKS, 1919-22

For suspended and settling solids the averages for the years covered are superimposed on the curves for the individual years. The range and frequency data for the remaining chemical and for the bacterial results require separate diagrams for individual years and for averages by years, to avoid confusion of the many curves, so the first are placed above and the second directly below. The three sets of curves in the lower right-hand corner show the average bio-chemical oxygen demand and the bacterial counts for the trickling filter influent and effluent, also per cent production.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

A Nicely Padded Brickbat

Sir—I note in your issue of Oct. 4, 1923, editorial comment on the Wisconsin Act fining an employer $90 for laying off a laborer; your final sentence is, "one is inclined to applaud the experiment." It is pertinent to inquire how long, in your opinion would a contractor remain in Wisconsin if the act becomes a law? A few years ago Texas fixed a mortgage rate by legislation and three days later the legislators returned for a special session and repealed the original act when the fiscal companies announced their intention of calling all mortgage loans when due, and lending no more money on mortgage as security. Kentucky fixed insurance rates in the same way and similarly rescinded its action immediately on finding the companies would quit business in that state. Your opinion and applause of the Wisconsin Act seem less carefully considered than most of what appears in your editorial columns.

In your skits on the "hot dog" and other popular varieties of engineers appearing in the daily press, you weaken your case very materially when you approve editorially (Nov. 8, 1923, p. 748) of: "Engineering is essentially economics—it is doing for one dollar what any fool can do for two." Permit me to disagree absolutely with the latter half of the definition which has the weight of your endorsement. My "vapor engineer" cleans my clothes for one dollar in a way which I cannot do for two, yet your high authority does not incline me to believe that the recognized definition, ". . . the direction of the forces of nature, etc.," has been superseded by the dollar mark. Consistency on your part should dictate a change of your version of engineering, or applause for the "hot dog" variety which your definition includes. As a matter of fact if you insist on dollars being included, engineering frequently means a refusal to do for one dollar a thing requiring two dollars for the proper doing.

Even a monkey falls out of a tree once in a while, which like your editorial lapses, occurs so infrequently that it is immediately noticeable.

EDWIN H. WARNER,
M. Am. Soc. C. E.

Burlingame, Calif.
Jan. 18, 1924.

Experience with Autogenously Welded Air Receiver

Sir—The art of welding by the various autogenous processes has developed to such a point that, with the comparatively inexpensive equipment now available, welding can be done at almost any repair plant. This has resulted in a great saving over old methods but it has its limitations, and failure to appreciate these limitations has led to frequent disappointment and occasional disaster. Probably the greatest abuse of the process is in the welding of joints in small boilers and air receivers, especially the latter. These frequently are small affairs, placed in inconspicuous corners. Owing to their simplicity, they are given little thought and frequently no inspection or care. And yet a receiver holding only a few cubic feet of air can create a considerable disturbance if it "lets go" under ordinary pressures of 80 to 100 lb.

To illustrate the potential danger in one of these apparently insignificant pieces of equipment, the writer was engaged a short time ago to investigate an explosion which occurred in a large industrial plant. The conditions were found to be as follows:

A two-stage compressor was located in the engine room, where it was subject to close observation by trained power house employees. The main air receiver, of perhaps 150 cu.ft. capacity, was in an adjoining room but convenient for frequent inspection. The automatic regulator for the compressor was set to shut off at 85 lb. pressure while the safety valve on the main receiver was set at 125 lb. This receiver was well designed, with riveted joints and properly reinforced outlets.

To serve certain elements of the plant in a separate building, a 1-in. pipe line was run for a distance of 300 ft., but it was found that as the demand on this line increased, a considerable drop in pressure occurred. To equalize the pressure at the end of the line over short periods of excessive use of air, an auxiliary receiver was installed in the detached building, near the point of use of air. This receiver was built at a nearby boiler shop. It was inspected and tested only by the manufacturers. It was of the simplest type, a cylinder 6 ft. in length by 2 ft. in diameter, with dished heads. The cylinder and heads were of ¼-in. material. Each head was ⅛ in. greater in diameter than the cylinder, thus providing for an overhang of ⅛ in., as indicated by Fig. 1. Each head was attached to the cylinder by oxyacetylene welding.

After this small receiver had been in use for several months, it failed, one of the heads blowing off and causing a serious personal injury. Fig. 1 shows a section of the weld which was sawed from the head which did not fail. So far as could be ascertained, this fairly represents the entire weld of either head, excepting that at a few points the welding metal appeared to have penetrated for a short distance between the end of the shell plate and the head. A microscopic examination of such penetrations, however, indicated that no material additional bond was found at these points. Maximum effective contact was $\frac{1}{16}$ in.

While the precaution of chamfering the edge of the material forming the shell (as illustrated in Fig. 2) was omitted, thus increasing the hazard over ordinary construction, users of pressure vessels might well doubt the advisability of using even properly welded joints for such service. A welded joint saves material, it has a neat appearance and if properly designed and executed should have ample strength, but satisfactory inspection is difficult if not impossible. Riveted construction usually costs more but its strength may be determined with a reasonable degree of accuracy and a careful inspection will disclose faulty workmanship.

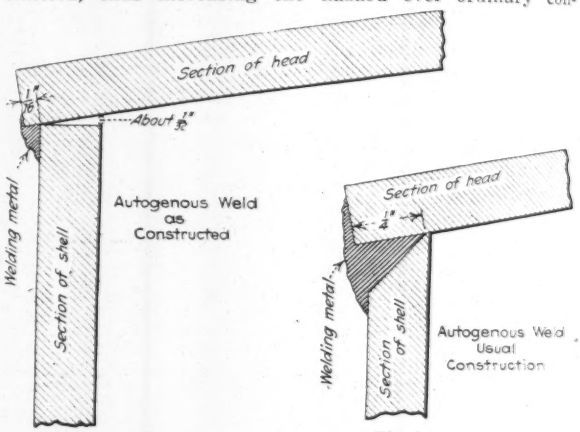


Fig. 1 Fig. 2

RIGHT AND WRONG WAY TO WELD AIR RECEIVER HEAD TO SHELL

Receiver head, welded by method shown in Fig. 1 sailed through the air for 100 ft., neatly cutting off a laborer's leg.

The following is quoted from the report of a committee of the American Society of Mechanical Engineers appointed to "formulate standard specifications for the construction of boilers and other pressure vessels":

Par. 186, *Welded Joints*—The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 25,000 lb. per square inch with steel plates having a range of tensile strength of 47,000 to 55,000 lb. per square inch. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the Code and where the safety of the structure is not dependent on the strength of the weld.

ARTHUR M. SHAW,
Consulting Engineer.

New Orleans, La., Jan. 13, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Oregon-Washington Railroad & Navigation Co. has been authorized to extend its railroad from Crane to Burns, a distance of 30 miles in Harney County, Oregon. The estimated cost of construction is $1,076,000.

The First Unit of the New Subway system for Genoa will be undertaken in the near future according to a press report. It will be 2½ miles long with nine intermediate stations and is to be the first unit of a system of 15½ miles.

The New York State Public Service Commission has directed the elimination of certain railroad crossings in Niagara Falls, New York, which will involve an outlay of about $1,200,000. One-half of the cost is to be borne by the railroad, one-quarter by the City of Niagara Falls, and one-quarter by the state.

The Tenth Annual Conference on highway engineering is to be held by the University of Michigan Feb. 11-14. The conference is under the direction of the College of Engineering, in co-operation with the Michigan State Highway Department and the Michigan Association of Road Commissioners and Engineers.

No Action on the Proposed standard specifications for excavation was taken at the recent annual meeting of the Levee and Drainage Contractors' Association, held at St. Louis on Jan. 16 and 17, in connection with the National Drainage Congress. R. H. McWilliams, Memphis, Tenn., was re-elected president; secretary, C. S. Gannon, St. Louis, Mo.

Determined Efforts are to be made at this session of Congress to extend federal aid to the highway system of Hawaii. Representatives of that Island now in Washington point out that Hawaii pays more internal revenue than fourteen states which they list. Its contributions to the liberty loans and to the draft during the war compare favorably with those from any state. For these and other reasons which are being advanced, the Island contends it is entitled to federal assistance in the matter of highway construction.

The Montreal Central Terminal Co., which was incorporated by the Dominion Parliament in 1890 to build a bridge and tunnel, or either, at Montreal, and to lay out a terminal and other works in the city, and was refused any further extension of its charter powers in 1923, the Board of Railway Commissioners having refused approval of its plans in 1921, has given notice of application to the Quebec Legislature for an act to give its company all the powers it had under the Dominion Acts, subject to the Quebec Railway Act, and to change its name to Montreal Tunnel and Terminal Co.

Dismiss War-Camp Construction Indictment

District of Columbia Supreme Court Justice Sustains Demurrer, Exonerating Crowell, Starrett and Others

In the Supreme Court of the District of Columbia on Jan. 30 Judge A. E. Hoehling dismissed the indictment that the Attorney General had brought in December, 1922, against the members of the Construction Committee of the Council for National Defense for alleged conspiracy to defraud the government in connection with the construction of the army contonments in the summer of 1917. The men indicted, who have been thus exonerated, were Benedict Crowell, Cleveland, Ohio, later the Assistant Secretary of War; C. W. Lundoff, contractor of Cleveland; William A. Starrett, an architect of New York, later a colonel in the construction division of the army; Morton C. Tuttle, of Boston, a contractor; John H. McGibbons, of Chicago, a surety man; Clair Foster, of New York, a contractor and later major of engineers; James A Mears, of New York, also a contractor.

In his decision Judge Hoehling said that although the indictment is divided into four parts: (a) certain recitals by way of *inducements*, (b) the *charge* of the conspiracy, (c) divers *means* by which the conspiracy was to be effected, and (d) *overt* acts, in all arguments before the judge the government admitted that the indictment charged but a single offense, a conspiracy to defraud the United States by prejudicing the orderly administration of its laws by its regularly constituted officers and agents. The government rested its principal case on the supposed violation of Section 3709 of the Revised Statutes which requires that purchases of supplies and services except personal be made by advertising proposals, except when the public exigencies require immediate delivery or performance together with the several army regulations consequent to this section. The judge notes that the indictment furthermore puts in two criminal statutes of the United States, but thereafter fails to make any criminal charge on the strength thereof. He therefore dismisses these statutes from further consideration. His decision then recites what an indictment should contain and attacks this one on the ground that it has only one charge positively alleged and is accompanied by a great amount of vague allegations which in oral argument the government admitted to be not pertinent.

Secretary Within Powers

In specific reference to the indictment the Judge first destroyed the contention that the Corps of Engineers is legally empowered or required to build camps. He admits that there is a possibility that the function of the corps includes the laying out of camps, but the Secretary of War was quite within his legal privilege in having the construction assigned to some other part of the department, therefore there could be no conspiracy to influence the Secretary of War to have some other department build the camps because there is nothing illegal in so doing.

The Judge then discusses the allegations in the indictment that the accused influenced "responsible officers" unnamed in disparagement of the Corps of Engineers. He answered this briefly by reference to the high standing of the Corps of Engineers in the department and the appreciation they were held in

Santa Fe to Build Second Track

The Atchison, Topeka and Santa Fe Ry. Co. has announced that construction will be started at once on double tracking 45 miles of the main line east of San Bernardino, Calif., between Hicks and Summit. No tunnels are involved in this work which on its completion will give the company a double track line practically all the way from Los Angeles to points in New Mexico.

Pigeon River Power Development May Start in Near Future

A report from Tennessee states that work on the Pigeon River project of the Pigeon River Power Co., situated between Asheville and Knoxville, will probably be started in the near future. The development of this site has been agitated for several years, but difficulties with owners of riparian rights and the uncertainty of the power market delayed action. It is understood now that the American Power & Light Co. has secured a controlling interest in the Pigeon River Power Co., and is in a position to start the early development of 60,000 hp.

Philadelphia Engineers to Hold Paving Conference

On Feb. 20 the Philadelphia Engineers' Club will hold a city paving conference, one session in the afternoon and one in the evening. The tentative program includes discussion of the general organization of the city paving department, maintenance of city pavements, control of street openings and methods of restoration, reconstruction or repaving of city streets, and the effect of traffic and methods of adjusting cost of repairs. An invitation has been extended to many engineers and others interested in city paving to attend the conference.

by the Secretary of War, both before and after the war which indicates that the secretary was not influenced against the corps but merely selected the best means of getting the construction work done. "Can it be," adds the judge, "that the wisdom or unwisdom, the propriety or otherwise, of the action of the Secretary of War as it reflects upon the defendant herein can now be made the subject of judicial inquiry or review."

The judge then, in effect, characterized as ridiculous the contention that there was anything illegal in carrying out the construction of the camps by a form of contract which did not require competitive bidding. The statute in question provides that in the case of emergency the Secretary of War is empowered to procure articles or service by open purchase or contract. On April 12, 1917, the Secretary of War "in perfectly plain language, entirely free from ambiguity" ruled and directed that this emergency existed and the requirement of competitive bidding would not necessarily have to be complied with. The government had contended that this was a specific ruling applying only to one case. The Judge waived that away and held that the ruling was general and legal. In oral argument one of the attorneys for the government has said, "I take my place finally upon the ground that section 3709 is the section under which the government operated; that that section was the law throughout the emergency and that any accomplishment in contradiction of that section was in violation of law. If this section be not the law upon which must be founded all contracts for materials, supplies or service other than personal, then insofar as competitive bidding is concerned the allegations of the indictment fall."

Cost-Plus Contract

The final part of the judge's decision relates to the cost-plus contract. He dismisses as being without basis the charge that the contract was prepared "to confuse, delay, hinder and prejudice the government's war construction program." He says that this is but the mere statement of the pleader, entirely lacking the allegation of facts upon which the conclusion, justifiably or unjustifiably, is intended to be based. He states further that the cost-plus contract was both extensively and successfully used by many branches of the government during "the great emergency of war as a means for securing a great many of the facilities and instrumentalities for successfully carrying on the war and no decisions have been cited in the court holding such contracts to be illegal or invalid, although some cases have been cited showing them to have been upheld as valid and enforcible." He calls attention to the fact that the preparation of the cost-plus contract was carried on openly in legal conformity and that it was approved by Secretary of War Baker, both before it was put into effect and afterward in his report. The Secretary of War with the particular executive officers of the government was charged with the duty and responsibility of seeing to it that the work was done and done properly and timely. He therefore is the responsible party. Furthermore the Judge says that there was no proof in the complaint that the building construction program was "grossly, unconscionably and fraudulently favorable to the contractor and in like manner to the same extent unfavorable to the United States" or that "the contract omitted certain important and substantial safeguards in behalf of the United States," both of which were charged in the indictment. Finally, he said that the Secretary of War was a responsible officer of the government, that he was advised by his Chief of Staff and other subordinates and that there is no reason to assume or infer that he could have been misled into adopting the policy of the War Department in its war building construction program. The whole charge against the defendant centers on mistakes or errors on matters of policy which the Secretary of War himself decided.

"The court is of the opinion that while the indictment abounds in the statement of conclusions, it fails to support the same by facts alleged as required in a criminal pleading; and furthermore, it is sought herein to obtain a judicial review of the policy adopted by the Secretary of War concerning the war emergency building construction program of that department, throughout the period of the late war; and that, too, in the absence of fact allegations that would make such review proper; even assuming, but not hereby deciding, that the question is one open to judicial review. Even if the order of the Secretary of War of April 12, 1917, may be properly construed as limited in application as insisted herein by counsel, notwithstanding the plain and unambiguous language of the order itself, as well, also, if notwithstanding the official adoption and approval by the Secretary of War of the cost-plus form of contract, a court and jury nevertheless may supervise and either reconstruct the terms and provision of such form of contract and the court is of the opinion that the indictment as drawn is not such that the defendants could advisedly plead thereto in the sense of knowing just what they are called upon to answer or what is intended to be proved thereunder. Accordingly the court is of the opinion and so orders that the demurrers filed herein be, and the same hereby severally are, sustained."

Spavinaw Water Project Tunnel Holed Through

Tiawah Tunnel, a 7,000-ft. solid rock tunnel on the Tulsa Spavinaw Water Project has been holed through after twelve months of excavation. There was practically no variation in the connecting line and grade. This variation was kept to a minimum by checks made from the surface every 200 ft., through the 8-in. vertical well holes used to ventilate the tunnel. This tunnel is a horseshoe section 84-in., in diameter and was worked from four headings, one at each end and two from an intermediary shaft. The concrete lining is approximately 50 per cent completed.

Progress by Port Authority Shown in Report

Does Not Favor 57th St. Bridge—Belt Line Service Undertaken—Will Help with Commuter Problem

The Port of New York Authority in its annual report to the governors of New York and New Jersey, favors the construction of vehicular tunnels for traffic between the lower parts of Manhattan Island and New Jersey in preference to building one large bridge at 57th Street. It does, however, favor the construction of a bridge about 178th Street, New York, a point where the physical conditions of both shores lend themselves to the construction of such a bridge.

The Port Authority recommends the construction of a number of universal freight stations on Manhattan Island so located that they can be adapted in the future to underground approaches for either electric railway or truck transportation.

In commenting on the progress toward the realization of its comprehensive plans for the development of the Port of New York the Port Authority draws attention to the fact that the trunk railroads on the New Jersey shore are now co-operating in making the necessary physical changes in their tracks so that belt line No. 13 between Bayonne and Edgewater can be operated as a single unit with a director of operation in charge and an unofficial observer to check up results in behalf of the Port Authority and the public. Moreover, active negotiations are now being carried on looking toward the construction of the section of belt line No. 1 on the west side of the Bergen Hills in New Jersey.

New Jersey Suburban Service

With reference to the New Jersey commuter service the report says that although its task is that of effectuating the comprehensive plan and unifying terminal freight service, it would gladly co-operate with any agency which the two states might create for the solution of this problem.

In commenting on the fact that it intervened in the hearings of the Interstate Commerce Commission on railroad consolidation the Port Authority report states that it believes that if the Central Railroad of New Jersey is not to be excluded from the consolidation it should be disposed of so as to permit the establishment of what would in effect be two new trunk lines to the West, serving the interests of both the New York Central Railroad and the Baltimore & Ohio.

The Port Authority also intervened in the Drayage Allowance Case before the Interstate Commerce Commission and in commenting on this the report says that the testimony was brought out to the effect that the saving to the Erie Railroad in the motor truck service from its New Jersey terminal to Manhattan, in the conduct of its inland operation, ranged from 80 cents to $1.60 per ton, and that substantial benefits accrued therefrom to shippers and consignees.

Extensive Program of Municipal Work Planned for Dallas, Tex.

An extensive program of municipal construction has been planned for Dallas, Texas. According to information received by *Engineering News-Record* from Major E. A. Kingsley, city engineer 35 street paving jobs have been awarded and bids will be received Feb. 11 for 55 more, making a total of 90.

This constitutes the major part of the 1924 paving program, meaning an expenditure of over $2,000,000. In addition to this amount there will be $300,000 spent on storm sewer work.

The city is also spending $500,000 for a disposal plant and sanitary sewer extensions, and concrete sidewalks are running from 4 to 5 miles monthly.

The $2,000,000 for pavement represents about one-third of the paving program contemplated, and will cover the three years, 1924-25-26. The yardage covered by the $2,000,000 means about 25 miles of 30-ft. streets and it is expected by the end of 1926 to have added about 75 miles of permanently paved streets.

Practically all of the paving construction is asphaltic surface, using 5-inch and 6-inch reinforced concrete foundations. The curbing is concrete combined curb and gutter, using a 12-in. gutter reinforcing to tie into the concrete foundation.

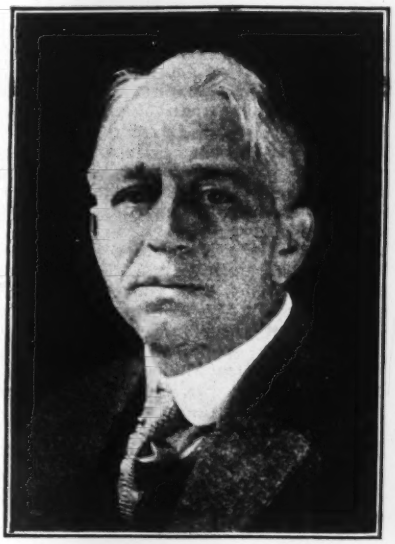
Surveys have been made, Major Kingsley announces, for a new water supply and it is expected that location will be finished for a reservoir within the next few weeks; $5,000,000 in bonds have been voted for the new water supply. This work should be completed by the end of 1925.

House Military Committee Favors Ford Muscle Shoals Bid

The Committee on Military Affairs of the House of Representatives has reported to the House that it approves Henry Ford's bid for Muscle Shoals as embodied in the Mackenzie bill and the Madden amendment. This action followed defeat of amendments to hold Ford personally responsible for full performance of every stipulation in the proposed contract, and to put his bid under the water power act, limiting a lease thereunder to 50 years.

Just before the hearings closed, E. H. Hooker, the president of the Hooker Electrochemical Co. of Niagara Falls, on behalf of himself, Gen. W. W. Atterbury, vice-president of the Pennsylvania R.R. Co., and J. G. White, head of the White Engineering Co., of New York, submitted the fourth offer in connection with the Muscle Shoals properties. The Hooker offer proposes the formation of a company, in which the United States will own 75 per cent of the stock, to operate the water power and the nitrate plant, offering as an evidence of good faith to contribute an operating fund of $1,000,000. During the first ten years they are to receive 2.67 per cent of the profits of the operation and after that 2 per cent. The balance goes to the government. They agree to set aside certain sums for research purposes.

New President of Associated General Contractors



Frederick L. Cranford

Mr. Cranford, long active in the committee and official work of the Associated General Contractors, was elected that association's head at the recent meeting in Chicago. F. L. Cranford, Inc., of which the new A.G.C. president is head, is one of New York's best known firms.

Industrial Preparedness Needs Assistance of Engineers

Plans for industrial preparedness as outlined at the dinner held under the auspices of the Army Ordnance Association and the engineering societies at New York on Feb. 5, include a detailed study of the requirements of an army of a specified size which will show the amounts of each class of raw material required, the source of supply, the location and size of the existing plants, the number and layout of special plants and the available source of labor. In laying out the work the army has divided the country into 14 districts which will eventually be advised as to just what material each will be expected to furnish.

Before the plans are completed it is hoped that it will be possible to have blank form of standard contracts in the hands of all of the larger manufacturing plants, which contracts can, in an emergency, be completed at a moment's notice. In this work the War Department realizes that it can only be carried out by co-operation from the manufacturers and producers of raw material in planning how best their men and resources can be used. Col. Walsh, chief of ordnance, New York district, said that the government depends on the engineers to give of their experience in dealing with these problems and suggested that they enlist the services of ambitious young men in their organizations in the study of how the organization can be worked into the general scheme.

Canada Wants More Engineers to Study St. Lawrence

The State Department on Feb. 5 received an official communication from the British Government replying to its note of Nov. 17, 1923, in which the United States government suggested either the immediate conclusion of a treaty looking to the development of the St. Lawrence along the lines suggested by the International Joint Committee, or the constitution of a joint committee of experts to make preliminary studies and to frame a treaty. The reply states that the Canadian government points out that the report of the International Joint Committee recommended that before any work was carried out, the Joint Engineering Board, whose proposals it generally approved, should be enlarged, and that, once so enlarged the said board should further consider the technical aspects of the problems in detail and decide upon the plan which should be adopted.

The Dominion Government is accordingly prepared to appoint additional engineers to enlarge the Joint Engineering Board, with a view to the board undertaking the preparation of a final report covering the engineering features of the whole project, including its cost.

The reply from the British government adds that the Dominion Government is also ready to nominate one or more technical officers to discuss with similar United States officers the form which the instructions to the enlarged Joint Engineering Board should take, and the time within which the board should be directed to report.

Extent of Damage by "Leviathan" to Passaic Outfall Sewer

Three breaks on the south pipe line on three consecutive pipe sections covering a distance of about 100 ft. and no damage whatever to the north branch of the Passaic Valley outfall sewer beneath New York Harbor have been disclosed by the investigation made by the Passaic Valley Sewerage Commissioners to ascertain the damage occasioned by the steamer *Leviathan* when it ran aground in New York Harbor on Dec. 21 (see *Engineering News-Record*, Jan. 3, p. 34). The outfall pipes in question extend southeasterly from the terminal chamber or uptake shaft of the Passaic Valley outlet sewer near the Robbins Reef lighthouse in New York Harbor. The breaks in the pipe line are about 1,100 ft. easterly from the uptake shaft and 400 ft. westerly from the point where the outlet nozzles in the branch pipe begin. The pipe where damaged is approximately 30 ft. below mean tide level, and the depth of fill over the damaged pipe was from 3 to 4 ft. Each of these outlet pipes was built of reinforced concrete in 50-ft. sections, having a shell thickness of 7¾ in. and an interior diameter of 8 ft. The foregoing statements are based on information sent to *Engineering News-Record* by J. Ralph Van Duyne, chief engineer, Passaic Valley Sewerage Commissioners on Jan. 31.

Iowa Engineers Reduce Dues; Stick to A. E. C.

Reduction from $10 to $6 Agreed on; C. S. Nichols Elected New President

Engineering News-Record Staff Report

Nearly 250 engineers and those interested in engineering registered at the Cedar Rapids convention of the Iowa Engineering Society, Jan. 29, 30, 31 and Feb. 1. Reflecting the general low ebb of financial feeling of this agricultural state the members present concluded that a $10 annual due was too burdensome and approved a reduction to $6, which means giving up the former idea of a year-round activity with paid assistance and a return to an annual-convention existence with in-between work carried on by gratuitous executive and committee work. The society closed its last fiscal year with a $1,000 deficit because of $1,200 uncollected dues. The secretary reported 23 resignations and 65 members dropped for non-payment of dues. Regardless of these defections in the ranks, new members are coming in and the net membership now is but 35 below the 506 of last year. Changing the dues is a by-law matter and must go to letter ballot following the convention action.

Support Engineering Council

Iowa engineers are staunch supporters of the American Engineering Council and unanimous action was taken, following a spirited report on activities by L. W. Wallace, secretary, to "stay in" although the $513 bill for dues to the former F.A.E.S. was partially responsible for the depleted condition of the treasury. The general opinion seemed to favor paid national activity but not that of the state.

By another change local clubs having at least 10 state society members may be represented on the board of direction which is made up of officers and elected representatives from 20 geographical districts having approximately the same membership in each district.

Technically the Iowa Society is thoroughly subdivided into six sections, each of which put on a heavy detailed program on one day.

In the section meetings the following are the principal subjects considered: The drainage section took up drain tile testing, friction factors and segment-block construction; the highway section, paints for steel, apportioning aggregates by weight, and the rapidly curtailed construction program which the Iowa Good Roads Association hopes to revive in its campaign for a bond issue. The mechanical-electrical section discussed turbines, gas, rates of electric service, the new Flynn-Weichel motor and the results of a series of tests comparing horses and motors. The municipal section subjects were planned programs, sewage treatment, special assessments; the railroad section, taxation and welding rail joints.

Of the general papers one by R. E. Robertson, county engineer, Mason City, astonished his audience with plain facts as to what has taken place in the Bureau of Reclamation. C. H. Young, consulting engineer, Muscatine, gave some sound advice to engineers should they be called on to give expert testimony. An engineer's service should include fact finding as well as testimony and help to the attorney during the trial. W. H. Finley, chief engineer, Chicago & Northwestern Ry., urged the engineer to enter the political field; the time is ripe and the engineer is fitted.

Ill-advised waterways and those for which there is only demagogic demand, such as the Hennepin Canal in Illinois, were deplored. So was the attitude of the Interstate Commerce Commission in not permitting low rates to the Pacific Coast which would permit competition with the Panama Canal routes and allow the roads to load their present empty west-bound cars.

Results of the final balloting for officers for 1924 are as follows: President, C. S. Nichols; vice-president, J. J. Hinman, Jr.; new director, B. J. Lambert. Chairmen of the sections are as follows: Drainage, W. A. Olson; highways, Raymond Zack; mechanical-electrical, B. P. Fleming; municipal, Earle Waterman; railroads, W. L. Wilson; structural-architectural, A. R. Coffeen.

W. L. Saunders Heads United Engineering Society

William L. Saunders, chairman of the Naval Consulting Board and deputy chairman of the Federal Reserve Bank of New York, has been elected president of the United Engineering Society, succeeding J. Vipond Davies. Mr. Saunders is chairman of the board of the Ingersoll-Rand Co. and a director in other corporations. He is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers and the Iron and Steel Institute.

George H. Pegram, chief engineer of the Interborough Rapid Transit Co., New York City, was chosen first vice-president; J. V. W. Reynders, vice-president of the American Institute of Mining and Metallurgical Engineers, was named second vice-president; Alfred D. Flinn was elected secretary; and Joseph Struthers, treasurer.

The total membership of the Four Founder Societies was shown by the report of the retiring president to be 54,224. Membership of the associate societies aggregates 25,615.

Establish Fellowship for Study of Phosphorus Brittleness

According to announcement of the Carnegie Institute of Technology, a fellowship in metallurgy has been established at the Institute. The first problem to be studied under this fellowship is an investigation of the effects of small percentages of phosphorus on the physical properties of low carbon steel, especially under alternating stresses and shock. The fellowship pays $750 for the ten months of the college year. Applications for the remainder of the current year may be sent to W. E. Mott, director of the College of Engineering, Carnegie Institute of Technology, Pittsburgh.

Random Lines

Sir: In this column in your issue of Jan. 31, I notice that you would like to know "what in blazes that professor" is going to do when he shoots a rocket to the moon.

Dr. W. J. Humphreys, professor of meteorological physics in the U. S. Weather Bureau wrote recently in "Science Service" on Professor Goddard's scheme:

> It would be a great advantage to the meteorologist to know the composition and temperature of the upper atmosphere at heights above those already explored by sounding balloons. On both these points observations and theories based upon meteors and auroras are in radical conflict with each other and both differ entirely from the hitherto recognized orthodox theories. The Goddard rocket gives promise of definitely settling the question of conditions at such high altitudes. It would be possible to construct apparatus that would bring down samples of the air at any desired height and at the same time register temperature and pressure without using the delicate and expensive recording instruments now employed.

All of which appears to be the characteristically clouded explanation of science when it seeks to find justification for experiments that have little or no practical application. Does it mean, for example, that weather forecasting will then become a precise art? And even definite information as to the substance of other planets cannot, it would seem, add much to the useful knowledge of the earth inhabitant. It might much more conceivably destroy illusion and mystifying fancies to which naïve man clings. For instance, how many juvenile bubbles would suddenly burst were the fact scientifically determined that the moon was not made of green cheese!

N. Y. C.

* * *

Boy! Page the Carnegie Foundation Engineering Education Investigation.

Situations open ad in *Engineering News-Record*: "Wanted, An engineer who can write."

* * *

Engineers on the Ether

W. W. DeBerard, Western Editor of *Engineering News-Record*, spoke from radio broadcasting station KYW, Chicago, on Jan. 22, on "What the Civil Engineer Has Done for the Middle West." The talk was not well received in the East, we are informed. Mr. DeBerard was compelled to wait until an astrologer had finished telling about the signs of the zodiac.

On Feb. 2, Groundhog Day, station KDKA, Pittsburgh, announced as a special treat for the kiddies a dream-time talk by "the man who imitates the animals, Edward Godfrey." Mr. Godfrey, who in civil life is a well known structural engineer, had entertained from this station before. He rendered a stockyard medley *au naturel*, a song in what appeared to be Italian dialect, and an interesting boys' story of a nelefunt. In closing, Mr. Godfrey told his young listeners "When you write, you may call me Uncle Ed." Here's a pointer to those who happen to be involved in the next public discussion of shear in concrete

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting (20th anniversary), Chicago, Ill., Feb. 25-28, 1924.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, March 11-13, 1924.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Sixteenth Conference, Los Angeles, Calif., April 7-10, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Atlanta, Ga., April 9-12, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., May 12-14, 1924.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

The Colorado Society of Engineers at its annual meeting, Jan. 19, elected the following officers: F. C. Steinhauer, president; R. J. O'Rourke, vice-president; C. M. Lightburn, secretary-treasurer. The meeting was attended by 200 members and guests, with the mayor of Denver the guest of honor.

The Engineers Club of Minneapolis, at its annual meeting, Jan. 26, elected the following officers: E. S. MacGowan, president; N. W. Elsberg, vice-president. W. T. Ryan, retiring president, in his annual address stated that the club during the past year had concerned itself with the university stadium, the municipal auditorium, public lighting, the high dam, garbage disposal and street maintenance.

The Engineers Society of Western Pennsylvania at its forty-fourth annual meeting held at Pittsburgh on Jan. 22 elected the following officers: President, Frederick Crabtree; vice-president, W. E. Fohl; treasurer, A. Stucki; and secretary, K. F. Treschow.

Personal Notes

ELIHU THOMSON, consulting engineer, General Electric Co., has been awarded the Lord Kelvin Gold Medal, and will go to England during the coming summer to receive it. The award was made by British and American engineering societies acting jointly. The medal is awarded every three years as a mark of distinction and for excellence in original research work in engineering. Professor Thomson is the first American to receive this honor. His studies in the electrical field have covered a wide range; his inventions in dynamo, electric machinery, electric welding, watt-hour meters, lightning arresters and magnetic arc extinguishers are fundamental. He was a pioneer in arc lighting, and innumerable electrical devices have been improved through his work.

CHRISTOPHER T. CHENERY, formerly an executive engineer with Sanderson & Porter, Chicago, Ill., has established offices at 11 Broadway, New York, for consulting practice in civil engineering with regard to valuations of public utilities or business properties, surveys, negotiations for franchises and contracts, and other economic phases of utility engineering.

HEGEMAN-HARRIS CO., INC., announces change of address from 185 Madison Ave., New York City, to 360 Madison Ave.

J. A. MICHELS, Red Lion, Pa., has been retained as borough engineer by Red Lion Boro, York County, Pennsylvania, to draw up designs, estimates and specifications and to supervise the construction of pavements during 1924. The borough constructed $200,000 of hard surface pavements in 1923.

MAJOR A. J. TAUNTON has been elected president of the Association of Professional Engineers of the Province of Manitoba.

ASSOCIATED SPECIALISTS, INC., announces the opening of offices in Planters Bldg., St. Louis, Mo. The firm, which now has offices in New Orleans, Philadelphia, Wilmington, Del., and New York City, renders services in accounting, taxation, technical, industrial, financing, purchasing and civic fields, on engineering projects.

R. H. THOMSON, consulting engineer, former city engineer, of Seattle, Wash., has been appointed assistant to T. R. Beeman, county engineer of King County, and will be especially engaged in the Green River deepening project.

WILLIAM L. REYNOLDS, of Denver, Colo., was certified by the Colorado Civil Service Commission as state railway and hydraulic engineer, to succeed C. D. VAIL who has accepted the position of manager of parks for the city of Denver.

W. F. SCHWARTZ has been appointed commissioner of public works, Buffalo, N. Y., to succeed A. W. KREINHEDER.

DABNEY H. MAURY, consulting engineer, Chicago, announces that FRED G. GORDON, formerly his principal assistant, has become associated with him as a partner. The firm of Maury & Gordon will continue the practice of hydraulic, sanitary and municipal engineering.

LAWRENCE D. KINGSLAND, 2D, is now engineer in the hydraulic division of Stone & Webster, Inc., Boston. For three years prior to his going with that organization he was with the Foundation Co. at Lima, Peru, where he was connected with the development of the new water supply for that city.

CAPT. H. C. WHITEHURST will have charge of the work on the south side of the Tennessee River at Wilson dam of the Muscle Shoals project. He will be at the head of Construction Division 2 and the work will include the power house section. He has been at the dam several months, and now succeeds Major Butler who has been transferred from the Wilson dam to Panama. Captain Whitehurst entered the army in 1918 and while in service in France was for a time regimental adjutant of the 306th Engineers; later he was on the general staff at Langres. After the war he was in charge of the engineering depot of the army supply base at Norfolk, Va.

ALFRED E. STROBEL, designing engineer with the Chicago, Burlington & Quincy R.R., has resigned his position and opened his own office at 110 So. Dearborn St., Chicago, for the practice of structural engineering.

JOHN L. ELLIOTT, city engineer of Indianapolis, was recently elected president of the sanitary commission of the city. The Indianapolis sanitary commission is distinct from the city government, being governed by laws passed by the state legislature and not the city administration.

PHILIP L. VOSS, consulting civil engineer, announces the opening of his office at 508½ Market St., Parkersburg, W. Va., and will practice in municipal and hydraulic engineering, and dams, highway construction, and masonry bridges.

C. MILES BURPEE has resigned as resident highway construction engineer with the New Brunswick, Canada, Department of Public Works to become head of the department of drawing and descriptive geometry at the Engineering College of Marquette University, Milwaukee, Wis.

Obituary

GEORGE M. MAHER, civil engineer, Albany, N. Y., died Jan. 10 of pneumonia at the home of his parents in Oneida, N. Y., at the age of 38 years. Mr Maher had long been employed in the New York state canal and highways bureaus.

WILLIAM SMITH GARDNER, consulting engineer, Montreal, of the firm of J. R. Gardner & Son, consulting engineers, died Jan. 8 in Montreal at the age of 74 years. Mr. Gardner was born in Pittsburgh, Pa., but had lived practically all his life in Canada.

WILLIAM J. CROOK, pioneer railroad building contractor, died at his home in Denver, Colo., Jan. 24, aged 83 years. Mr. Crook was a native of Tipperary, Ireland, and went to Colorado in 1868. He built a great deal of the Denver & Rio Grande R.R., the Denver & Salt Lake, the Santa Fé in Colorado and the El Paso and Southwestern from El Paso to Bisbee.

WILLIAM W. RANDOLPH, consulting engineer in utility enterprises, died Jan. 23 at his home in East Orange, N. J., after a long illness. Mr. Randolph was born in 1864 and was educated at the University of Virginia and at Stevens Institute of Technology. As a consulting engineer, he was engaged to appraise gas properties in many cities, and recently had been retained to fix the valuation of the holdings of the Public Service Gas Co. and the Public Service Electric Co of Newark, N. Y.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Minimum Trade-In Value for Used Mixers Established by Manufacturer

New Guarantee Policy Also Provides Schedule of Definite Rebuilding Costs for Both Light and Heavy Machines

By R. C. Weller
President, Marsh-Capron Co., Chicago

LAST summer a series of meetings, sponsored by a joint committee of manufacturers and contractors whose chairman was C. E. Bement of the Novo Engine Co., was held in Chicago to consider the standardization of concrete mixers. Preliminary to one of these meetings, a little group were discussing various matters in the anteroom of the engineer's rooms. One of the men in this group was R. C. Marshall, Jr., general manager of the Associated General Contractors of America. He outlined the need of establishing in some way a value on contractor's used equipment. The problem was discussed briefly by those present and it appeared that there was a need for such a move, but no decision was reached. Since that time, however, the Marsh-Capron Co. has taken this problem under consideration with the results outlined below.

Minimum Values Fixed

On all mixers shipped after Jan. 1, 1924, the Marsh-Capron Co. is issuing a Certificate of Guarantee. These certificates contain the usual guarantee against defective materials or workmanship for 1 year and the guarantee that is implied by our participation in the standardization proceedings. In addition, there is a guarantee to the effect that any drum wearing out within 5 continuous years of service, from normal usage, will be replaced free of cost.

The big feature, however, is the fact that a definite minimum value is established on any used Marsh-Capron mixer over a period of 3 years, definite rebuilding costs are established on the small and lighter machines over a period of 5 years, and on the larger and heavier machines over a period of 10 years. The details of these guarantees are shown in the accompanying tables.

With regard to the definite trade-in value, we have extended the time to 3 years; possibly this time could have been extended further, but we are sailing uncharted seas and must proceed slowly. At first glance it would also appear that the three points named, Philadelphia, Pittsburgh and Chicago, might be unduly restrictive of the application of the guarantee, but arrangements have been made at quite a number of additional points to handle used machines in carload lots, with the absorption of a considerable portion of the freight necessary to move them to the three points named. This will extend the scope of this guarantee very materially.

At first glance it would also appear that the allowances made are not as liberal as they might be. This is possibly true if only the physical depreciation of a machine is considered. There is, however, a very substantial shrinkage in the value of a machine immediately after it is used, due to the payment of the distributor's commission, the cash discount, the advertising, sales expense and profit of the manufacturer and the physical depreciation of the machine itself. An examination of records running over a period of eleven years leads us to believe that the physical depreciation per year on a 3½-S, 5-S or 7-S mixer runs from 15 to 20 per cent, whereas the total depreciation the first year, including the items mentioned, runs from 55 to 80 per cent. On the larger machines—the 14-S, 21-S and 28-S—the indication is that the physical depreciation runs from 10 to 15 per cent per year, while the total depreciation the first year runs from 45 to 70 per cent. These facts make it unsafe to announce, initially, a larger guaranteed value than that shown.

The rebuilding costs, on the contrary, may look somewhat high, but after the first year, due to the growing preponderance of gas power in the mixer industry, it was necessary to figure that on a considerable portion of the machines it would be necessary to furnish an entirely new gas engine. It was found possible to extend the rebuilding period on the smaller machines to 5 years and on the larger machines to 10 years, as the possible costs would be more surely estimated than in case of guaranteeing a minimum value.

We have presented these facts and figures personally to nearly 200 contractors throughout the country and without exception their opinion was that this is a step in the right direction and that the guarantees are as liberal as any business man could be expected to make.

MINIMUM TRADE—IN VALUE OF USED CONCRETE MIXERS

Age from Date of Shipment	3½-S	5-S	7-S	14-S	21-S	28-S
	Percentage of Current List Prices					
One year and less	25	25	25	30	30	30
Over 1 year and less than 2	20	20	20	25	25	25
Over 2 years and less than 3	15	15	15	20	20	20

SCHEDULE OF MAXIMUM REBUILDING PRICES

Age from Date of Shipment	—Cost of Rebuilding— 3½-S	5-S	7-S
One year and less	$100	$200	$300
Over 1 year and less than 2	125	225	350
Over 2 years and less than 3	150	250	400
Over 3 years and less than 4	175	275	450
Over 4 years and less than 5	200	300	500
	14-S	21-S	28-S
One year and less	$350	$450	$550
Over 1 year and less than 2	475	575	675
Over 2 years and less than 3	600	700	800
Over 3 years and less than 4	725	825	925
Over 4 years and less than 5	850	950	1,050
Over 5 years and less than 6	975	1,075	1,175
Over 6 years and less than 7	1,100	1,200	1,300
Over 7 years and less than 8	1,225	1,325	1,425
Over 8 years and less than 9	1,350	1,450	1,550
Over 9 years and less than 10	1,475	1,575	1,675

J. D. Adams, Inventor of Leaning-Wheel Grader, Dies

J. D. Adams, founder and head of the firm of J. D. Adams & Co., Indianapolis, Indiana, died of pneumonia Jan. 17, following a brief illness. He was nationally known as the inventor of the adjustable leaning-wheel graders which bear his name.

With limited means and in a very limited way Mr. Adams started the manufacture of his leaning-wheel graders about 1895. Working practically single-handed he began the introduction of his graders in various parts of the country, making up a few machines, going out on the road and selling them, and then returning to repeat this process. The merit of his product and his efforts to be of service to his customers bore fruit until today his graders are in widespread use throughout the country and the organization he built up ranks among the largest in the country specializing on road graders.

In the latter years of his life Mr. Adams spent most of his time on experimental work, the active management of the business being in the care of his sons, R. E. Adams, general manager, and W. R. Adams, general sales manager, who will continue in active charge.

Paving Brick Industry Active

A sharp increase in unfilled orders for vitrified paving brick in December is reported by the National Paving Brick Manufacturers Association. Unfilled orders in December had jumped to 60,624,000 brick, as against 54,535,000 for November. This is considered an accurate gage of the demand for early spring and summer shipments. Stock on hand exceeds the total of unfilled orders. Contractors and engineers, the paving brick manufacturers state, are assisting in relieving the seasonal aspect of the paving brick industry by asking for winter deliveries, shipments for December amounting to 12,979,000.

Kansas led in consumption for December followed closely by Ohio.

Construction Machinery Exported

The following exports of American construction machinery during the month of October, 1923, are reported by the Department of Commerce:

Fifty-six concrete mixers costing $54,728; 12 power shovels costing $182,565; miscellaneous road-building equipment costing $60,283; miscellaneous construction equipment costing $51,537; 80 conveyors costing $22,883; 18 cranes costing $53,333; and 196 hoists and derricks (except mining) costing $43,932.

Business Notes

BUHL CO., Chicago, manufacturer of portable and stationary air compressors, has added a 55-cu.ft. unit to its line. This machine has all the features of the company's 80-ft. compressor, such as force-feed oiler, high-tension magneto with impulse starter, and built-in governor. Both the compressor and engine are inclosed.

PAWLING & HARNISCHFEGER CO., Milwaukee, has appointed Norman P. Farrar as district manager with offices at 605 Stephen-Girard Bldg., Philadelphia, and 50 Church St., New York. Mr. Farrar has had 14 years' experience in the sale of crane and hoist equipment.

BLAW-KNOX CO., Pittsburgh, has placed Charles K. Wehn in charge of a special department devoted to standard steel buildings and structural steel in Illinois and adjoining states; his headquarters will be in the People's Gas Building, Chicago.

MIDDLETON-WHITTAM, INC., 565 Fifth Ave., New York, is a new firm established to provide for the working of American-owned patents and processes by British organizations. William Whittam, one of the members of the firm, was formerly special agent in England for the United States Department of Commerce.

MILWAUKEE CORRUGATING CO., manufacturer of Milcor sheet metal products, announces the purchase of several factory buildings and the establishment of a branch plant at La Crosse, Wis. The new works will begin operation Mar. 1, under the management of Frank Vyvyan, who has served at the company's Milwaukee plant for twelve years.

The UNIVERSAL CRANE CO., Elyria, Ohio, has appointed H. A. Hutchins general sales manager, with offices in Cleveland. Mr. Hutchins was formerly district manager for the Thew Shovel Co. at Chicago.

UNITED STATES CAST IRON PIPE AND FOUNDRY CO., Burlington, N. J., announces the following additions to its sales force, effective Jan. 1: H. A. Hoffer, eastern sales manager, with headquarters in Philadelphia; G. T. Overholt, acting New York sales agent, with headquarters in New York City; Thomas Simons, Kansas City sales agent, with headquarters in Kansas City, Mo.

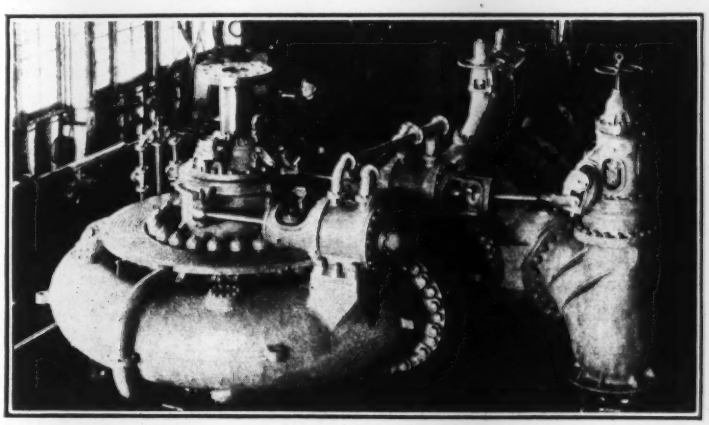
PAWLING & HARNISCHFEGER CO., Milwaukee, has recently received what is claimed to be the largest single order ever placed for electric traveling lumber-handling cranes. The purchaser is the Long Bell Lumber Co. The order includes 21 cranes and hoists and 7,000 ft. of mono-rail track to be installed at a new lumber mill in Long View, Wash.

MONROE CALCULATING MACHINE CO., Orange, N. J., has been awarded prizes, as a result of competitive tests for accuracy and speed, by the Commercial Organization Exhibition at Paris and the International Exhibition of Inventions at Turin.

Equipment and Materials

Ship World's Highest-Head Reaction Turbine

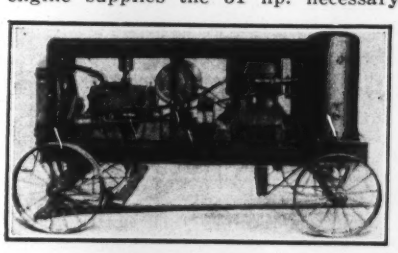
From the Oak Grove hydraulic unit of the Pelton Water Wheel Co., San Francisco, there has just been shipped to the Portland (Ore.) Railway, Light & Power Co., the world's highest-head reaction turbine, designed to operate under an average effective head of 857 ft. The unit, a shop photograph of which is shown herewith, has a capacity of 35,000 hp. at 514 r.p.m., and weighs with accessories approximately 100 tons. The shipment required five cars.



The turbine is of the vertical type and will be direct-connected to a General Electric generator. It is equipped with a Pelton oil-pressure governor system, with load-limiting device and is arranged for remote-control operation at the switchboard. One of its features is a 79x50-in. butterfly valve cast integral with the release valve and operated by electric motor, water motor or hand control, as desired. To eliminate leakage, protect wearing parts and compensate for minute eccentricities, if any, in rotation of the shaft, the turbine is fitted with the company's patented rubber seal rings.

Portable Air Compressor Has New Features

Increased capacity has been provided in the new model (WK-311) of the portable air compressor design by the Sullivan Machinery Co., Chicago, for the use of road builders, general contractors and public utilities. Mounted on a four-wheel truck body and weighing 6,050 lb., the machine has a displacement of 170 cu.ft. of air per minute. A Buda four-cylinder gasoline engine supplies the 31 hp. necessary to operate at 450 r.p.m. against 100 lb. per square inch pressure.



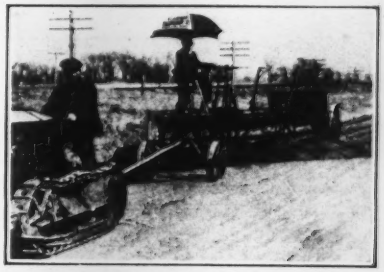
Lubrication is by a force feed oil pump, delivering under 15 to 25 lb. pressure to all bearings, instead of the more common splash oiling system. The air valves are of the company's improved water plate type. The power of the engine is delivered to the compressor through reduction gearing consisting of high-carbon, double-treated pinion and gear.

The outfit is housed under a steel canopy and removable steel sides for protection against the weather and tampering. Instead of the steel-rimmed wheels shown the truck may be equipped with rubber-tired wheels.

The capacity of the compressor, its manufacturer points out, is sufficient to operate two rotator hammer drills at 100 lb. pressure for holes up to 14 ft.

Multiple-Blade Road Maintainer

Designed for operation by a 15-30-hp. tractor, the multiple-blade Havelock maintainer, manufactured by the Highway Maintainer Co., Lincoln, Neb., is equipped with four independent but overlapping blades, each 42 in. long, which may be adjusted to fit the contour of a roadway. These blades provide a cutting width of 13 ft. 6 in. which may be increased an additional 4 ft. by the use of extension blades.



The blades are of 5x$\frac{5}{8}$-in. crucible steel, detachable for sharpening or replacement. All moldboards and cutting edges are interchangeable. By means of a 24-in. hand-wheel a master-lift device raises all blades at one operation. In addition, individual blade levers provide for quick adjustment of each blade to any cutting depth desired. For operation with a tractor one of the features of the equipment is an offset hitch which holds the grader in a straight line while the tractor drives near the center of the road.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Commercial Building in 1923 Was 4 Per Cent Above 1922 Volume

Engineering News-Record statistics covering commercial (not industrial) building awards of $150,000 and over shows that this class of construction was fairly active in all parts of the country last year. The yearly total of awarded contracts places 1923 ahead of the five preceding years. The sections falling below their 1922 record are: New England, Middle Atlantic and Middle Western. The graphs of the two years show them following the same general trend in all the geographic divisions. The peak of building construction for 1922 was in May with a total of over $85,000,000. This height was not reached in 1923, but a series of peaks coming in February, April and June, with totals of over $77,000,000 and $77,000,000 and $81,000,000, respectively, offsets the one of 1922.

During 1922, there were 1,928 awards totaling $750,762,000 with an average of $389,400 compared with the 2,140 awards of 1923 valued at $813,392,000 and averaging $366,000.

Building construction trend may be seen by the tabulations of the yearly totals for the last six years compared with 1913. The actual physical volume in terms of 1913 cost is also given. This is obtained by applying the *E. N.-R.* Construction Cost Index Number as in the fourth column of the following table:

Year	Total Value	Monthly Average	Actual Volume
1913.....	$148,687,650	$12,391,000	100
1918.....	116,938,674	9,745,000	42
1919.....	337,285,854	26,440,000	114
1920.....	581,324,693	48,444,000	155
1921.....	568,261,252	47,355,000	184
1922.....	750,762,000	62,564,000	289
1923.....	813,392,000	67,783,000	255

The year 1924, including the date, January 31, shows the following trend of building construction, according to Construction News in *Engineering News-Record*:

Proposed Work		Bids Desired	
No.	Est. Value	No.	Est. Value
526	$300,526,000	157	$41,841,000
Bids Received		**Contracts Let**	
No.	Est. Value	No.	Value
24	$10,441,000	214	$88,555,000

Another numerical comparison of the years 1922 and 1923 taken from the various groups that the building item is divided into in Construction News follows:

Year	Proposed Work	Bids Desired	Bids Received	Contracts Let No.	Contracts Let Value
1923.....	4,671	1,534	264	2,140	$813,392,000
1922.....	3,683	1,503	208	1,928	750,762,000
1923 Gain.	988	31	56	212	$62,630,000

According to geographic sections the building situation for 1922 and 1923 has been as follows:

	1922 No.	1922 Value	1923 No.	1923 Value
New England	175	$65,298,000	172	$55,494,000
Middle Atlantic	642	281,521,000	620	254,585,000
Southern	143	44,366,000	182	64,547,000
Middle West	578	225,628,000	546	217,357,000
West of Miss.	232	72,913,000	311	103,845,000
Western	158	61,036,000	309	117,564,000
Total	1,928	$750,762,000	2,140	$813,392,000

Some noteworthy items in the 1924 proposed work are the following:

Lakeland, Fla., Home of Brotherhood of Carpenter and Joiners, $5,000,000
Brooklyn, N. Y., Municipal building, $4,000,000.
New Haven, Conn., Yale University Library, $4,000,000.
Pittsburgh, Pa., Hotel, $6,000,000
New York City, Parlex Building Corp. building, $18,000,000
New York City, Apartment Hotel—T. C. DuPont, $18,000,000.

The Pacific Telephone and Telegraph Co. of San Francisco has appropriated $40,000,000 for its 1924 construction program.

Bids Wanted on Big Jobs

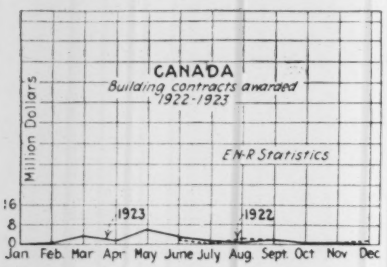
Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 71 to 83, are the following:

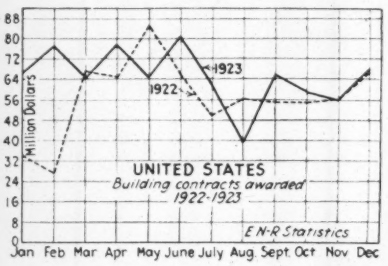
Dock, Ashland, Wis., Minneapolis, St. Paul & Sault Ste. Marie Ry. Co., $1,000,000-$1,500,000.

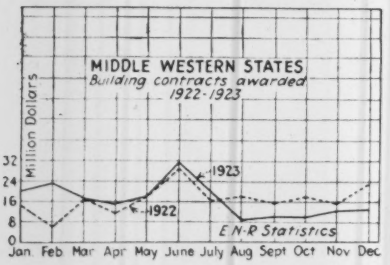
Hotel, Detroit, Mich., Webster Hall Hotel Co., $1,500,000.

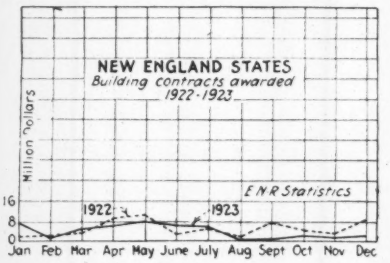
Hotel, Boston, Mass., Statler Hotel Co., $4,000,000.

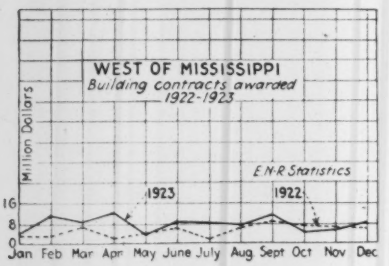
Canal, Shrewsbury, La., by Bd. Comrs., $1,500,000.

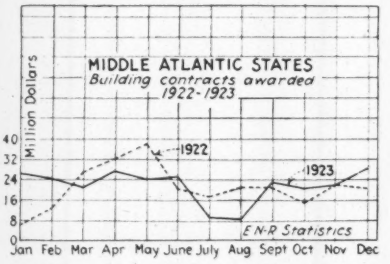


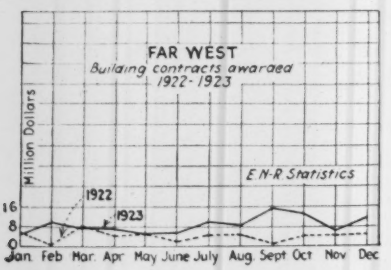


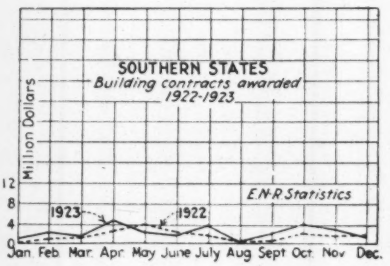












Value of January Contracts Eight Per Cent Under Same Month Last Year

All Classes Gained During Month Except Bridges, Streets and Roads —Actual Volume Greater Than January, 1921-22

The total value of contracts awarded on large engineering construction projects, in the five January issues of *Engineering News-Record*, reached $164,722,000 as compared with $126,221,000 in the four issues of December. This represents an average weekly value of $32,944,400 for January, against $31,555,250 during the preceding month. January, 1923, lettings totaled $142,599,000.

Minimum costs observed in Construction News on each class of construction are as follows: Water-works, $15,000; other public works, $25,000; industrial construction, $40,000; and commercial buildings, $150,000.

All classes of construction gained during January with the exception of streets, roads and bridges. Water-works, sewers, excavations, drainage and irrigation projects more than tripled the December totals in money value of contracts awarded. Substantial gains were also shown in industrial works and commercial buildings.

The actual physical volume of construction represented by January contracts, is 17 per cent under the same month in 1923; 14 per cent heavier than January, 1922; over twice the volume for the corresponding period in 1921 and 11 per cent below January, 1920.

Among the large projects awarded during January were the following: A hotel and theater building, Boston, Mass., $8,500,000; generating plant, Somerset, Mass., $5,750,000; hotel, Chicago, Ill., $5,000,000; office building, Detroit, Mich., $5,000,000; printing plant, Philadelphia, Pa., $2,500,000 and a motor repair shop, New York, N. Y., $2,325,000.

Engineering News-Record Construction Cost Index Number

February, 1924	**220.30**
January, 1924	**217.90**
February, 1923	**197.40**
Peak, June, 1920	**273.80**
1913	**100.00**

1923

Jan.	191.70	July	222.10
Feb.	197.40	Aug.	221.50
Mar.	205.25	Sept.	221.50
Apr.	213.50	Oct.	220.30
May	216.70	Nov.	220.90
June	220.70	Dec.	217.30

Engineering News-Record's Construction Cost Index Number gained 2.4 points since last month, owing to price advances in lumber and cement. The average rate for common labor is still 54c., which rate has remained in effect since June, 1923. Thus, general construction cost is 12 per cent higher than one year ago and 20 per cent under the peak; it is 120 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Monthly

January, 1924	*(5 issues of E. N.-R.)*	**130**
December, 1923	*(4 issues of E. N.-R.)*	101
January, 1923	*(4 issues of E. N.-R.)*	126

Yearly

1923 (entire year)	135
1922 (entire year)	130
1921 (entire year)	88
1920 (entire year)	91
1919 (entire year)	91
1913 (entire year)	100

Engineering News-Record's Construction Volume Index Number is 130 for the month of January, and 135 for the whole of 1923, as against 100 for 1913. This means that the actual volume of construction in 1923 (not the mere money-value of the contracts let that year) is 35 per cent above the volume of construction for 1913. Our monthly volume number, 130 for January, 1924, is really the increment of construction, and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING JANUARY, 1924

	New England	Middle Atlantic	Southern	Middle West	West of Mississippi	West	Total United States	Canada	Grand Total
Waterworks	$254,000	$387,000	$377,000	$455,000	$1,556,000	$478,000	$3,507,000	$1,031,000	$4,538,000
Sewers	60,000	601,000	338,000	1,022,000	1,106,000	1,612,000	4,739,000	.....	4,739,000
Bridges	26,000	407,000	216,000	936,000	1,083,000	253,000	2,921,000	25,000	2,946,000
Excavation, drainage, etc.	.....	7,000	2,163,000	393,000	.....	.....	2,563,000	.....	2,563,000
Streets and roads	1,292,000	2,479,000	3,096,000	998,000	4,268,000	4,839,000	16,972,000	.....	16,972,000
Industrial works	7,143,000	8,731,000	5,649,000	4,422,000	2,024,000	2,975,000	30,944,000	635,000	31,579,000
Buildings	12,592,000	32,744,000	5,675,000	19,145,000	9,213,000	9,183,000	88,552,000	924,000	89,476,000
Federal Government	.....	996,000	453,000	.....	384,000	1,259,000	3,092,000	.....	3,092,000
Unclassified	300,000	1,933,000	300,000	608,000	1,639,000	1,883,000	6,663,000	2,154,000	8,817,000
Total	$21,667,000	$48,285,000	$18,267,000	$27,979,000	$21,273,000	$22,482,000	$159,953,000	$4,769,000	$164,722,000

Labor Rates and Conditions Throughout the Country

A slight increase in unemployment is indicated in the latest report of the U. S. Department of Labor, covering fifty-two of the more important industries. The heaviest decreases in employment occurred recently in the sugar refining and confectionery industries, also in railway car building and repairing.

Reports of increased employment, however, are received from the automobile tire and cotton textile industries. The three most favorable factors in the 1924 industrial outlook are (1) the proposed four-year agreement with the United Mine Workers, to be effectuated without strikes or suspension of production; (2) agreement on 5 per cent advance in wages, affecting 15,000 employees of the New York Central lines; and (3) the signed agreement between twenty-nine New York building trades and the employers, to remain in effect for two years.

A slight increase in average hourly earnings of factory workers is reported by the National Industrial Conference Board. Rather sharp advances in a few industries, notably automotive, iron and steel, paint and varnish and book and job printing, more than balanced smaller declines in the majority of industries covered.

The average rate paid common laborers (pick and shovel men) in construction operations, remains 54c. per hr. for the entire country. The same rate has prevailed since June, 1923, according to *Engineering News-Record* figures. Local conditions follow:

Atlanta—Labor situation satisfactory with exception of shortage of plasterers and tile setters. Construction outlook good. Building materials prices, however, tending upward.

Baltimore—Labor conditions normal.

Boston—All building crafts plentiful.

Cincinnati—Average increase of 15c. per hr. to all building trades except hod carriers and common laborers, who will receive advances of 2½c. per. hr. Present high wage schedule due to fact that there are three jobs to every man in Cincinnati building trades.

Dallas — Bricklayers and carpenters in greatest demand; ample supply of other trades.

Kansas City—Plenty of men in all building trades. Carpenters advanced to $1.17½ from $1.12½ per hr.

Los Angeles—Small surplus of men in all building trades since first of the year. Slight tendency, however, to-

CURRENT BUILDING TRADES WAGE RATES PER HOUR
(Higher rates indicated by +, decreases by —)

Cities	Brick-layers	Car-penters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.50	.90@1.00	1.00@1.12½	+1.00	$0.65	1.12½	.40
Birmingham	1.00	1.00	.50@1.00	.30@.40	.....	1.00	.30@.40
Boston	1.25	1.00@1.10	1.25@1.35	.82½	1.05	1.12½	.60@.75
Cincinnati	+1.50	+1.15	+1.15	+.90	+1.15	+1.15	+.52½
Chicago	1.25	1.15	1.00@1.25	.88¾	1.10	1.25	.82½
Cleveland	1.40	1.25	1.25	.87½	1.00	1.10	.87½
Dallas	1.50	1.00	1.00	.40	.87½	1.00	.30@.50
Denver	1.37½@1.50	1.12½	1.12½@1.18¾	.75@.81¼	1.00	1.15⅝	.35@.55
Detroit	1.12½	.80	.80@.90	.50@.60	1.00	.60@.80	.50
Kansas City	1.37½	+1.17½	1.00@1.25	.90	1.00	1.00	.30@.75
Los Angeles	1.25	+.100	+1.00	.62½	.....	1.00	.50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	.40@.45
Montreal	.90	.65	.50	.35	.50	.65	.30
New Orleans	1.25	.90	1.00	.65	.80	1.00	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00	1.25	.62½@.75
Philadelphia	1.50	1.12½	1.02½@1.13¾	.70@1.00	1.00	1.10@1.12½	.45@.50
Pittsburgh	1.40	1.20	1.12½	1.00	.....	1.25	.70
St. Louis	1.75	1.50	1.25@1.37½	1.25	1.25	1.25@1.50	.45@100
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	.93¾	1.00@1.12½	1.12½	.62½

ward a higher building wage schedule.

Minneapolis—The 1923 wage schedule will hold throughout the current year. Peace and harmony prevail between employers and building trades mechanics.

New Orleans—Open shop conditions prevail in carpenter trade. Skilled and unskilled labor ample; plenty of materials.

New York — Twenty-nine building crafts have signed agreements with employers to hold for a period of two years. The wage rate of all these crafts will be $10.50 per day, base pay. About 90 per cent of the building trades mechanics are at present employed. Most of the unemployment is among excavators, the trades working above ground being fairly well occupied.

Philadelphia—Present wage schedule will obtain until May. Oversupply of all classes of building labor.

Pittsburgh—Plenty of building trades mechanics. Steel mills maintaining high production schedules.

St. Louis — Painters will demand, effective March 15, a rate of $1.50 per hr., Monday to Friday inclusive, and $3 per hr. for Saturday and Sunday work, against present scale of $1.12½ per hr. for 5½-day week, with double time for Saturday afternoons and Sundays. None of the unions now have a 5½-day week.

San Francisco — Wage schedule for 1923 to obtain throughout current year. Decrease in construction causing small amount of unemployment in building trades.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Basic iron in better demand with prices higher, owing to scarcity of heavy melting scrap; present quotation $25.77 per gross ton, Pittsburgh, against $29.27, one year ago. No. 2 foundry at Birmingham, $1 per ton under year ago.

Railway Supplies—Small demand for light rails; quotations as low as $43 per ton being made at Pittsburgh, against minimum of $45, one month ago. Standard spikes trifle higher at mill.

Pipe—Wrought pipe firm at present levels. Cast-iron pipe higher in Pittsburgh, St. Louis and San Francisco. Downward tendency in sewer pipe in Detroit, Cincinnati and Philadelphia. Clay drain tile same price as year ago in New York.

Road and Paving Materials—Petroleum output showing slight increase, particularly in Wyoming and Montana. At the same time Eastern crude oil prices are advancing. St. Louis reports rise in road oils. New York road-oils' prices lower than year ago; Dallas, higher. Package asphalt up $1.45 per ton in Minneapolis; bulk, $1.80, since last month. Mexican asphalt down $1 per ton at Maurer, N. J., despite sharp drop in imports due to revolt in Mexico. Five-inch granite paving blocks down $1 in Boston and $2 per M. in New York. Average drop of 26c. per sq.yd., on wood paving blocks in New York; advances of 20c. reported in St. Louis and 10c. per sq.yd. in Atlanta.

Sand, Gravel and Crushed Stone—Gravel advanced 25c. per cu.yd. in Seattle and the same amount per ton in Atlanta, during month; decline of 38c. per cu.yd. reported in Dallas. Sand prices tending higher throughout country. Although crushed stone declined sharply in St. Louis and about 5c. per ton in Boston, during month advances are reported in New York, Cincinnati and Atlanta. In New York the present level is $1.85 per cu.yd. f.o.b., for ¾-in., against $1.75, one year ago; the advance being due chiefly to higher construction cost of water transportation facilities.

Lime—Declines reported in Boston, St. Louis and Atlanta. In Atlanta, however, common lump rose 15c. per bbl. during month.

Cement—General tendency upward. Advances reported in Chicago, Milwaukee and Cedar Rapids, during month; rises expected at other important centers.

Steel—Bars are the firmest in price of any of the major steel items; quoted at $2.40 base, with plates and shapes, $2.50 per 100 lb., Pittsburgh. Despite recent heavy buying of fabricated structural steel, quotations of $2.35@$2.40 per 100 lb. have been reported on exceptional tonnages at Pittsburgh mills.

Brick and Hollow Tile—Common brick, $20@$22 per M., wholesale, alongside dock, New York, against $20, one month ago and the same price one year ago. Brick also higher in Boston and Atlanta. Declines, however, reported in Cincinnati and Detroit. Hollow tile fairly steady; advances serving to balance off declines. General level about that of year ago.

Lumber—Production, shipments and demand increasing rapidly; although current shipments and orders are below those of the corresponding period last year. As in the case of hollow tile, lumber price advances are offset by the declines.

Explosives—Few price changes in 40 and 60 per cent gelatin dynamite. Slight drop reported in Boston and St. Louis; rise of 2c. per lb. on 60 per cent, in Atlanta.

Scrap—Prices firm. Heavy melting steel scarce; quoted at $14 per ton in New York, compared with $13, one month ago.

Linseed Oil—General level about that of month ago. Other paint materials advancing.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton—Quotations compiled by The Matthew Addy Co.:

	Feb. 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$25.05	$27.55
Northern Basic	24.00	29.27
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	24.00	29.77
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	28.00	33.44
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	**23.00**	24.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	24.25	29.76@30.14
Virginia No. 2 (silicon 2.25 @ 2.75)	28.17	33.17
Basic	24.00	28.00
Gray Forge	24.00	28.14
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	24.50	29.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	27.00	30.01
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	25.77	28.00
Basic	25.77	29.27
Bessemer	26.77	29.27

SCRAP—The prices following are per gross ton paid to dealers and producers f.o.b. New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$16.00	$11.50	16@16.50
Stove plate	13.00	12.00	16.00
No. 1 machinery cast	18.00	16.50	19.50@20
Machine shop turnings	9.00	4.00	12.50@13.50
Cast borings	10.00	5.50	14.00
Railroad malleable	16.00	12.50	21.00
Re-rolling rails	14.00	13.00	21.50@22
Re-laying rails		30.00	28.00@31
Heavy melting steel	**14.00**	16.00	.....

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Feb. 7	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	.....	$43.00	$46.00
Standard openhearth rails	43.00	43.00	$43.00	43.00	46.00
Light rails, 8 to 10 lb.	*43@45	45.00	2.00*	43.00	2.55*
Light rails, 12 to 14 lb.	*43@45	43.00	2.00*	43.00	2.45*
Light rails, 25 to 45 lb.	*43@45	43.00	2.00*	43.00	2.35*
Rerolled Rails	37@40	28@32	.....	.....	2.10*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.70	$1.90
Chicago, Hardwood and Red Oak	1.35@1.45	1.50@1.70
Chicago....Empty Cell Creosoting (add'l)	.50	.60
San Francisco.....Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted. Douglas Fir	1.70	2.25
St. Louis, White Oak	1.30	1.60
St. Louis (creosoted) (zinc treated)	1.70	2.05
St. Louis, Red Oak, plain	1.20	1.50
St. Louis, Sap pine-cypress	1.05	1.35

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Francisco	Birmingham
	Feb. 7	One Year Ago	Chicago	St. Louis		
Standard spikes, ⅜-in. and larger	**$3.05**@3.15	$2.75@2.90	$3.00	$3.85	$4.85	$3.72
Track bolts	4.00@4.25	3.75@4.50	4.00	4.90	6.20	4.57
Standard section angle bars	2.75	2.75@2.90	2.75	3.45	4.00	3.20

PIPE

WROUGHT PIPE—The following mill discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	48%	50%	49%
2½ to 6 in. lap welded	44%	47%	46%
	Galvanised		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	34%	37%	36%
2½ to 6 in. lap welded	30%	34%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 34% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham Mill	Pittsburgh	New York Feb. 7	New York One Year Ago
4 in.	$53.00	**$59.20@60.20**	$67.10@68.60	$61.30
6 in. and over	49.00	**55.20@56.20**	61.60@63.60	56.60

	Chicago	St. Louis	San Francisco
4 in.	$60.20@64.20	**$58.60**	**$63.00**
6 in. and over	57.20@60.20	**54.60**	**59.00**

†Gas pipe and Class "A," $5 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin ft.:

Size, In.	New York Feb. 7	New York One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$45.00	$45.00	$50.00	$62.50	.....	$73.00
4	55.00	55.00	50.00	75.00	$76.50	83.00
5	80.00	80.00	.....	100.00	97.75	108.00
6	105.00	105.00	85.00	175.00	127.50	133.00
8	170.00	170.00	195.00	187.50	212.50	199.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.105	.....	.....	$0.15	$0.12	.....
4	.....	.105	$0.11	$0.1175	.15	.15	$0.15
5	.....	.1575	.1375	.....	.23	.18	.18
6	$0.24	.1575	.165	.1645	.23	.21	.21
8	.38	.245	.26	.26	.35	.30	.325
10	.57	.3675	.338	.364	.53	.42	.476
12	.72	.4725	.442	.468	.68	.54	.612
15	1.13†	.63	.65	.78†	.90	.90	.884
18	1.65†	.875	.85	1.092†	1.25	1.32	1.153
20	1.98†	1.05	1.125	.....	1.50	.....	.....
22	2.64†	1.40	1.375	1.456†	2.00	.....	1.564
24	2.97†	1.575	1.625	1.872†	2.25	2.16	2.04
27	4.81†	2.795	....	2.95†	4.69†	3.00	3.34
30	5.33†	3.096	....	3.65†	5.94†	3.60	4.06
33	6.93†	4.14	....	4.45†	6.88†	.....	4.99
36	7.91†	4.715	....	4.80†	7.50†	.....	5.42

	3	5	8	12	24	36
Boston	$0.129	$0.198	**$0.305**	**$0.595**	$1.99†	$5.97†
Minneapolis	.....	.....	.40	.72	2.55	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.13	.....	.36	.72†	2.60†	.....
Los Angeles	.13	.165	.275	.475	1.65	.....
New Orleans	.145*	.168*	.28	.476	1.182	.....
Cincinnati	*.11*	*.1665*	*.259*	*.4995*	*1.655*	**4.92†**
Atlanta	.11*	.165*	.275	.425	1.625	.....
Montreal, *delivered*	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	*.108*	*.162*	*.252*	*.486*	*2.205†*	*5.8425†*
Baltimore	.117	.175	.273	.5265	1.755	3.9975
Kansas City, Mo	.15*	.21*	.335	.52	2.09†	4.35†
Philadelphia	*.111*	*.167*	*.26*	*.50*	*1.675*	*5.12*

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Feb. 7	One Year Ago
New York, 45% asphalt	(at terminal)	$0.053	$0.06
New York, 65% asphalt	(at terminal)	*.051*	.06
New York, binder	(at terminal)	.06	.0675
New York, flux	(at terminal)	.06	.065
New York, liquid asphalt	(at terminal)	.048	.07
St. Louis, 40@50% asphalt		**.0575**	
St. Louis, 50@60% asphalt		**.06**	.0548
Chicago, 40–50% asphalt		.0525	.0525
Chicago, 60–70% asphalt		.055	.055
Dallas, 45% asphalt		.0495	.04
Dallas, 55% asphalt		.0455	.048
Dallas, binder		.061	.053
San Francisco, binder, per ton		9.50*	9.50*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00*	$15.00†
Boston (*Mexican*)	21.00	16.50
Chicago (*Stanolind*)	22.25	16.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	24.75	20.50
Denver (*California*)	24.00	
Minneapolis *f.o.b. Twin Cities* (*Stanolind*)	26.90	20.90
St. Louis (*Trinidad*)	33.30	28.80
Baltimore (*Standard Oil*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	24.00	21.50
Detroit (*Mexican*)	22.00	18.00
Cincinnati (*Kentucky Rock*)	17.50	13.50
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	*20.50*	*17.50*
Philadelphia (*Mexican*)	19.00	16.00
Kansas City (*Texas*)	27.30	22.30
Los Angeles "*D*" *grade, California, f.o.b. El Segundo Refinery*	17.00	11.00

*F.o.b. Bayonne, N. J.
†F.o.b. Marcus Hook, Pa.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	*$138.00* per M.
Chicago	About 4x8x4 dressed	3.60 per sq.yd.
	About 4x8x4 common	3.20 per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	*125.00* per M.
Atlanta	Granite	2.66 per sq.yd.
Detroit	5-in. Granite	106.00 per M.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4 x 8 x 4	3.25 per sq.yd.
Cincinnati	Granite	138.00 per M.
St. Louis	4x8x4 dressed	3.05 per sq.yd.
	4x8x4 common	2.90 per sq.yd.
Kansas City	Granite	3.75 per sq.yd.
Philadelphia	Granite	3.75@4.50 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.10 per lin.ft.
Chicago	18 in. wide	No market per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5 x 16 in., 85c.; 5 x 20 in., Queens, 85c. *St. Louis*: Class "A" straight, delivered, 5 x 16 in., *$1.35* per lin.ft. *Chicago*: 5 x 18 in., $3.35 per lin.ft. delivered.

WOOD BLOCK PAVING—	Size of Block	Treatment	Per Sq.Yd.
New York (*delivered*)	3	16	*$2.29*
New York (*delivered*)	3½	16	*2.56*
Boston	3½	18	*2.60*
Chicago	4	16	3.50
Chicago	3½	16	3.50
St. Louis	3½	16	**2.65**
St. Louis	4	16	**3.00**
Seattle	4	16	Off market
Minneapolis	3½	16	2.70
Atlanta	3½	16	**2.00**
New Orleans	3	16	2.50
New Orleans	3½	16	2.81
New Orleans	4	16	3.15
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	2.84
Detroit	4	16	3.00
Cincinnati	3½	16	2.38
Kansas City	4	16	3.00
Philadelphia	4	16	None used

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Feb. 7	Gravel 1½ In. One Year Ago	Gravel ¾ In. Feb. 7	Gravel ¾ In. One Year Ago	Sand Feb. 7	Sand One Year Ago
New York (*alongside dock*)	$2.00	$2.00	$2.00	$2.00	$1.25	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.00	2.25	2.00	2.25	2.00	2.25
St. Louis	1.40	1.40†	1.50†	1.50†	1.20	1.40†
Seattle	**1.50**	1.00	**1.50**	1.00	**1.50**	1.00
Dallas	*2.00*	2.25	*2.00*	2.25	2.00	1.87½
Minneapolis	1.85*	1.75*	1.85*	1.75*	1.25-**1.50**	1.00
Cincinnati	1.35†	1.40†	1.35†	1.40†	1.30†	1.15†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.40†	1.40	1.40†	1.40	**1.20**†	1.10
New Orleans	2.85	2.85	2.85	2.85	1.25	1.35
Los Angeles	2.50		2.50		1.75	
Atlanta	**2.00**†	1.75†	**2.00**†	1.75†	**1.42**†	1.24†
Detroit	1.62	2.25	1.62	2.25	2.02½	2.00
Baltimore	1.40	1.86	1.60	2.13	0.70†	0.70†
Montreal	1.25†	1.25†	1.50†	1.50†	1.25†	1.25†
Birmingham (Crushed slag used instead of gravel)					1.30†	1.25†
Philadelphia	2.15†	1.70	2.15†	1.75	1.65†	0.66*
Kansas City		2.00		2.00	0.66*†	0.66*

New York—Grits, $1.75 per cu. yd.; ready mixed, $2.00.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit.
† Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Feb. 7	1½ In. One Year Ago	¾ In. Feb. 7	¾ In. One Year Ago
New York	**$1.75**	$1.65	**$1.85**	$1.75
Chicago	2.00	2.25	2.00	2.25
St. Louis	*1.75*	2.00	*1.75*	2.10
Dallas	2.83	1.80	2.83	1.80
San Francisco	2.15	2.15	2.15	2.15
Boston	*1.50**	1.85	*1.50**	1.85
Minneapolis	1.85	2.00	2.00	2.25
Kansas City	1.50	2.25	1.50	2.25
Denver	3.50	3.50	3.50	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	**2.00***	2.00*	**2.00***	2.00*
Cincinnati	**1.70***	1.55*	**1.70***	2.00*
Los Angeles *delivered*	2.75		3.00	
Detroit	1.75	1.90@2.00*	1.75	1.90@2.00*
Baltimore	2.50		2.55	
Montreal	1.80*	1.80*	1.90*	1.90*
Philadelphia	2.15*	1.75*	2.15*	1.60*
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.00*	3.25*	3.00*

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.40	1.40	2.00	1.40
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	0.85	0.90	2.50	
Birmingham, Ala.	1.05	1.15	2.05	0.80
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.45	1.45	1.45	1.25
Eastern Pa. and Northern N. J.	1.20	1.20	2.50	1.20
Western Pennsylvania	1.25	1.25	2.00	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	1.00
Toledo, Ohio	1.50	1.50	1.50	1.50

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$13.10	$3.75*	$3.00@3.25*
Chicago	20.00	20.00	1.50†	1.50†
St. Louis	*19.00*	*19.00*	2.62½*	2.62½*
Boston	22.00	16.00	*4.20**	*2.70**
Dallas	20.00		....	1.85†
Cincinnati	16.80	14.30	....	13.40‡
San Francisco	22.00		....	2.10†
Minneapolis	25.50	21.00 (white)	1.70†	1.50†
Denver	24.00		....	2.70†
Detroit	20.00	19.00	18.00‡	18.00‡
Seattle, *paper sacks*	24.00	....	2.80†	....
Los Angeles	....	18.50	....	2.00†
Baltimore	24.25	17.85	2.55	....
Montreal	21.00	21.00	....	9.50†
Atlanta	*22.50*	14.00	2.25†	**1.65**†
New Orleans	....	....	2.40†	1.85†
Philadelphia	23.00	16.00	1.93*	1.24†
Kansas City	18.40	15.00	2.45*	2.45*
Birmingham	14.50	13.75	2.00†	1.80†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is white is $1.80, Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks; lump lime "alongside dealers docks" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b., exclusive of bags:

	Feb. 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	*1.75*	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	*2.65*	....
St. Louis (Carney)	**2.45**	1.75
Birmingham (Magnolia) pozzolan cement	2.10	....

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Feb. 7	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.60@2.70
New York, alongside dock to dealers	2.15	2.15	2.30
Jersey City	2.33	2.33	2.48
Boston	2.63	2.63	2.75
Chicago	**2.20**	2.10	2.05
Pittsburgh	2.19	2.19	2.14
Cleveland	2.41	2.41	2.36
Detroit	2.37	2.37	2.33
Indianapolis	2.31	2.31	2.26
Milwaukee	**2.35**	2.25	2.22
Duluth	2.19	2.19	2.04
Peoria	2.27	2.27	2.26
Cedar Rapids	**2.48**	2.38	2.33
Davenport	2.29	2.33	2.28
St. Louis	2.20	2.20	2.35
San Francisco	2.61	2.61	2.71
New Orleans	2.40	2.40	2.30
Minneapolis	2.42	2.42	2.29
Denver	2.84	2.84	2.85
Seattle	2.90	2.90	2.90
Dallas	2.05	2.05	2.25
Atlanta	2.35	2.35	2.50
Cincinnati	2.42	2.41	2.39
Los Angeles	3.16	3.16	....
Baltimore	2.50	2.50	2.51
Birmingham	2.80	2.80	2.40
Kansas City	*2.80*	2.27	2.35
Montreal	2.25	2.25	2.15
Philadelphia	2.41	2.41	2.41
St. Paul	2.42	2.42	2.29

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.85	Hudson, N. Y.	$2.05
Universal, Pa.	1.95	Leeds, Ala.	1.95
Steelton, Minn.	2.00	Bannibal, Mo.	1.95
Fordwick, Va.	2.05	Lehigh Valley District	2.10
Mitchell, Ind.	1.95	Wyandotte, Mich.	2.00
Iola, Kan.	1.95	Alpena, Mich.	2.05
Mason City, Ia.	2.00	Richard City, Tenn.	2.05
La Salle, Ill.	1.95	Kingsport, Tenn.	

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.95	$1.02	$1.24	$1.04	$1.12	$1.33
049	28	1.25	1.30	1.58	1.32	1.38	1.67
068	35	1.47	1.59	1.94	1.62	1.67	2.06
093	45	1.89	2.04	2.50	2.08	2.00	2.66
126	57	2.34	2.53	3.09	2.59	2.55	3.29
153	68	2.79	3.02	3.60	3.08	3.15	.....
180	78	3.20	3.47	5.22	3.54	3.47	.....
245	103	4.22	4.57	4.60	4.66	4.58	.....
287	119	4.88	5.28	6.44	5.39	5.26	6.88
336	138	5.66	6.13	7.39	6.25	6.11	.....
395	160	6.56	7.10	8.67	7.25	7.12	.....
		PAVING					
036P	17	$0.72	$0.78	$0.95	$0.79	$0.76	.....
053P	24	1.02	1.10	1.35	1.12	1.07	.....
072P	31	1.29	1.40	1.71	1.42	1.39	.....
097P	40	1.66	1.80	2.20	1.83	1.90	.....
049R	24	.....	1.10	.....	1.12	1.07	.....
067R	31	.....	1.40	.....	1.42	1.39	.....
089R	40	.....	1.80	.....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq. ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	*New York	Chicago	St. Louis	San Francisco	Dallas
27Dia.	2.3	$22.00	$21.25	*19.50*	$20.00	$25.50
26 "	2.5	22.00	22.50	*21.00*	19.11	27.58
25 "	3.0	22.00	25.25	*23.75*	.....	30.71
24 "	3.4	24.00	27.25	*26.00*	24.09	33.16
22 "	4.33	27.00	31.75	*30.75*	.....	35.10

*Price to contractors at warehouse or delivered on job in Manhattan, Bronx or Brooklyn.

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger..	$2.40	$2.70	$3.54	$3.20	$3.35	$3.38	$3.65
⅜	2.45	2.80	3.59	3.25	3.45	3.43	3.75
½	2.50	2.90	3.64	3.30	3.55	3.48	3.85
⅝	2.65	2.95	3.69	3.45	3.75	3.63	4.05
¾	2.90	3.00	4.04	3.70	4.35	3.78	4.65

For size and cutting extras, manufacturers and distributers, see bar card of July 1, 1923.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
¼ and larger	$2.30	$3.05	$3.08	⅜	$2.70	$3.30	$3.30
⅜ in.....	2.40	3.10	3.13	½	3.30	3.50	3.48
½	2.50	3.15	3.18	.....	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Feb. 7	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$23.65@25.85	$23.65	$23.50	$46.50	$54.00
New York (at dock)	20@22	20.00	20.00	.....	.....
Chicago	11.00	11.00	11.00	34.00	42.00
St. Louis, salmon	16@18	16@18	16.00	38@40	40@42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	11.60	11.60	9.85	33.00	.....
San Francisco	15.50	15.50	15.50	.....	.....
Los Angeles	14.50	14.50	.....	(not used)	
Boston (del.)	22.00	21.00	20.00	48.25	56.00
Minneapolis (del.)	16@18	16@18	17@19	.....	.....
Kansas City	16.50	16.50	14.50	(no market)	
Seattle	15.00	15.00	13.00	55.00	.....
Cincinnati	*17.00*	20.00	18.00	40.00	45.00
Montreal	16.50	16.50	16.00	100.00‡	68.00
Detroit (del.)	*17.50*	18.25	16.50@17.00	38.50	41.50
Baltimore (del.)	21.00	21.00	18.00	40.00	45.00
Atlanta	12.00	11.00	10.00	40.00	45.00
New Orleans	18.75	18.75	15.75	.....	.....
Birmingham	12.50@14.00	12.50@14.00	12.50	.....	.....
Philadelphia	21.00	21.00	20@28	38.00	46.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	16.00	16.00	16.00	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. † F.o.b. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Feb. 7 on Trucks*	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.1179	$0.123	*$0.064*	$0.125	$0.08	$0.108	.....
6x12x12	.1769	.1844	*.088*	.....	.11	.156	.....
8x12x12	.2211	.2305	*.12*	.215	.145	.244	$0.1968
10x12x12	.....	.....	*.1511*	.....	.17	.....	.2442
12x12x12	.....	.....	*.176*	.....	.215	.....	.3175

* 5 per. off for cash.

	4x12x12	8x12x12	12x12x12
Boston	$0.125	$0.23	.....
Minneapolis (f.o.b. cars)	.07	.12	$0.20
Minneapolis (delivered)	.075	.13	.21
Cincinnati	.07485	.13745	.....
Kansas City	.0965	.168	.....
Denver	.065	.123	.188
Seattle (delivered)	.11	.25	.36
Los Angeles	.0931	.1686	.....
New Orleans	.12	.23	.....
Detroit (delivered)	*.1044*	*.1968*	.2737
Montreal	.1154	.225	.30
Baltimore	.1252	.27	.....
Atlanta	.1004	.1674	.....
Dallas	.11	.20	.285
Birmingham	.11	.18	.....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.08	.164	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f. o. b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in	$2.50	$3.00	$3.64	$4.40	$3.45	$3.30	$3.60
Channels, 3 to 15 in	2.50	3.00	3.64	4.40	3.45	3.30	3.60
Angles, 3 to 16 in., ¼ in. thick	2.50	3.00	3.64	4.40	3.45	3.30	3.60
Tees, 3 in. and larger	2.50	3.00	3.64	4.40	3.50	3.30	3.60
Plates, ¼ in. thick and heavier	2.50	3.00	3.64	4.40	3.45	3.30	3.60

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York, Feb. 7	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$2.90	$4.40	$3.85	$3.75	$3.90	$5.00	$4.90

CONE HEAD BOILER

½ in. and larger	$3.10@3.15	$4.50	$3.95	$3.85	$4.10	$5.20	$5.00
⅝ and ¾	3.25@3.30	4.66	4.11	4.00	*4.35*@4.70	5.35	5.15
⅞ and 1	3.50@3.55	4.90	4.35	4.25	4.85	5.60	5.40

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00	$3.80	$4.25	$4.55	$3.36	$4.95
Cut	.....	4.45	5.25	5.75	*3.59*	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
¼	$9.20	$5.85	*$7.00*
⅜	7.40	5.60	*5.50*
½	7.25	5.45	*5.25*

Pittsburgh base in lots of 200 kegs or more, $3.25@3.50.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs **$2.71** per roll to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost **$6.95** per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in l) f.o.b. Philadelphia, l.c.l., **$6.10** per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$78.02
Tar pitch (in 400-lb. bbl.), per 100 lb	2.04
Asphalt roofing (in barrels), per ton, f.o.b. plant*	38.75
Asphalt felt (light), per ton, f.o.b. plant*	87.75
Asphalt felt (heavy), per ton, f.o.b. plant*	87.75

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—Double strength, box list, united inches, 34, "AA" grade, at discount of *85* per cent from standard lists, f.o.b. New York; "A" grade less *84* per cent; "B" grade, **86** per cent; "B B" grade, 88 per cent.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.00	$4.10	$4.00	$5.00	*$4.34*
No. 12	3.10	4.15	4.05	5.05	*4.39*
No. 14	3.20	4.20	4.10	5.10	*4.44*
No. 16	3.40	4.30	4.20	5.20	*4.54*
Black					
*Nos. 18 and 20	3.70	4.55	4.70	5.60	*4.55*
*Nos. 22 and 24	3.75	4.60	4.70	5.65	*4.60*
*No. 26	3.80	4.65	4.75	5.70	*4.65*
*No. 28	3.85	4.75	4.85	5.80	*4.75*
Galvanized					
No. 10	4.00	4.75	4.85	5.50	*4.80*
No. 12	4.10	4.85	4.95	5.60	*4.90*
No. 14	4.10	4.85	4.95	5.60	*4.90*
Nos. 17 to 21	4.40	5.15	5.25	5.90	*5.20*
Nos. 22 and 24	4.55	5.30	5.40	6.05	*5.35*
*Nos. 25 and 26	4.70	5.45	5.55	6.20	*5.45*
*No. 28	5.00	5.75	5.85	6.50	*5.75*

*For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages: for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Feb. 7	New York: One Year Ago	Chicago: Feb. 7	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.95	$0.93	$0.94	$0.98

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Feb. 7	1 Yr. Ago	Feb. 7	1 Yr. Ago
Red	**14.50**	14.25	**16.00**	15.75
White	**14.50**	14.25	**14.50**	14.25

LUMBER

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft	25 to 32 Ft.
3x3 and 4	*$35.00*	*$36.00*	*$37.00*	*$40.00*
3x6 and 8	*35.00*	*36.00*	*37.00*	*40.00*
4x4-6 and 8	*35.00*	*36.00*	*37.00*	*40.00*
3x10 and 12	*35.00*	*36.00*	*37.00*	*40.00*
3x14	*39.00*	*39.00*	*41.00*	*43.00*
4x10 and 12	*35.00*	*36.00*	*37.00*	*40.00*
4x14	*39.00*	*39.00*	*41.00*	*43.00*

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	*$37.00*	*$39.00*	*$41.00*
6x14	*38.00*	*40.00*	*42.00*
8x10	*37.00*	*39.00*	*41.00*
8x14	*38.00*	*40.00*	*42.00*

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	**$48.00**	**$49.00**	**$45.00**	**$47.00**
3x10 to 10x10	**53.00**	**54.00**	**50.00**	**53.00**
3x12 to 12x12	**56.00**	**57.00**	**58.00**	**60.00**
3x14 to 14x14	**65.00**	**66.00**	**64.00**	**66.00**
3x16 to 16x16	**73.00**	**74.00**	**72.00**	**74.00**
3x18 to 18x18	**93.00**	**94.00**	**82.00**	**84.00**
4x20 to 20x20	.....	.....	**92.00**	**94.00**

*Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12 x 12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	*$57.00*	*$68.00*†	*$53.00*	*$53.00*	*$75.00*	*$90.00*†
Seattle	.....	29.50	.....	.....	.....	*29.00*
New Orleans	**30.00**	.....	.....	.....	**42.00**	.....
Baltimore	33.50	53.00	53.00	60.00	38.00	53.00
Cincinnati	40.00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	.....	.....	.....	.....	65.00
Los Angeles	.....	49.00	.....	.....	.....	50.00
Denver	.....	40.75	40.75	40.75	.....	41.75
Minneapolis	44.00	44.75	*40.00*	.....	47.00	45.75
Atlanta	**36.00**	.....	.....	.....	**48.00**	.....
Dallas	50.00	.....	.....	.....	54.75	.....
Kansas City	44.75	48.50	.....	.....	58.75	49.50
Birmingham	30@35	.....	.....	.....	40@45	.....
Philadelphia	50.00	**42.00**	43.50	48.00	60.00	**43.00**
Detroit	**50.00**	*48.75*	.....	.....	*55.00*	*48.75*
St. Louis	*41.00*	.....	.....	.....	**54.00**	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	*$48.00*	*$55.00*†	*$46.00*	*$58.00*	*$63.00*†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	72.00	.....	.....	**34.00**	.....
Baltimore	60.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	**38.00**	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	44.00	.....	.....	.....
Denver	.....	**36.25**	**36.25**	.....	33.25
Minneapolis	47.00	*40.25*	*38.50*	*41.00*	*37.25*
Atlanta	**20.00**	.....	.....	**30.00**	.....
Dallas	50.00	.....	.....	53.33	.....
Kansas City	**75.75**	46.00	.....	64.75	.....
Birmingham	24@28	.....	.....	32@36	.....
Philadelphia	33.00	**42.00**	43.00	50.00	**41.00**
Detroit	*45.50*	**39.00**	.....	**55.00**	**41.00**
St. Louis	**43.00**	.....	.....	**31.50**	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M.ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

MISCELLANEOUS

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Feb. 7	One Month Ago	One Year Ago
$2.65	$2.65	$2.00@2.05

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Hercules red strand, all constructions	20%
Patent flattened strand, special steel wire rope	20%
Patent flattened strand, iron rope	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	**$0.16½@.18**	New Orleans	$0.15½
New York	.17½	Los Angeles	.20
Chicago	.18	Seattle	.18
Minneapolis	.17½	St. Louis	.16½
San Francisco	.15	Montreal	.22
Atlanta	.25	Detroit	.20
Denver	15½@16½	Baltimore	.18
Cincinnati	.19	Kansas City	.17½
Dallas	.21	Birmingham	.20½
Philadelphia	.17		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	*.23*	*.25*
Kansas City	.2125	.2325
Seattle	.165	.19
Chicago	.22	.25
Minneapolis	.1917	.2123
St. Louis	*.22*	*.245*
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1975	.2225
Atlanta	.23	**.2550**
Baltimore	.22	.23
Cincinnati	.225	.25
Montreal	.195	.235
Birmingham, *delivered*	.16	.17
New Orleans	.195	.22
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f. o. b. New York:

Sulphate of aluminum, in bags, per 100 lb.	$1.40@1.50
Sulphate of copper, in bbl., per 100 lb.	*4.65*@4.75
Soda ash, 58%, in bags, per 100 lb.	*1.25*@1.45
Chlorine, liquid, cylinders, 100 lb., per lb.	.08½@.09
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	**2.55@2.60**

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.215	St. Louis	.43
Denver	1.26	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.